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Analysis of the farms' economic and environmental status with welfare assessment of fattening pigs in Poland

Analiza stanu ekonomicznego i środowiskowego z oceną dobrostanu tuczników w polskich gospodarstwach

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mEAT quality

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Abstract

The aim of the study was to collect data and observations from 20 farms conducting conventional (intensive) as well as extensive fattening of pigs in different rearing systems in Poland.

The introduction of the study analyzed how the potential genetics of native and commercial fattening pigs are shaped. The issue of feed and how animal nutrition can affect their production parameters and meat quality was informed. In addition, the focus was on presenting the recommendations and standards that must be met to ensure good condition that allows this animal species to live freely. In the end of the literature review the market situation of pigs in Poland was presented as well as abroad.

The work was conducted based on a protocol developed by an international team for a project with the acronym "mEATquality." The study used questionnaires to assess the state of the farm in terms of: 1- management, 2- production economics, 3- environment as well as 4- welfare of animals kept on farms. The data obtained from pig breeders and producers in Parts 1-3 were from 2021 and allowed to illustrate the national production of fattening pigs, while direct observations in pens with animals were conducted during farm visits between June and December 2022.

The farms that were cooperating in the project, were mainly medium-sized family farms with family members working in them. Both the farm owner and his employees were unfamiliar and unable to estimate and value their own labor farm. The surveyed farms were dominated by a closed, conventional, intensive cycle/system. Farmers fed animals to a greater extent with feeds that were composed of materials from their own production, only supplementing with high-protein raw materials, vegetable oils and raw materials of mineral origin. Feed came from purchase only when there was a shortage of grain during the year. Native breeds used less efficiently feed per kg of weight gain. In terms of bioassurance, farmers declared that they were following the recommendations, while observations showed that it was not reflected in reality. The reported injuries in the observed animals, were due to the lack of diversity in the environment, and the least abnormal behavior was observed when the animals were kept on deep bedding. Restrictions used in production adversely affect the behavior of fattening pigs. The conducted observations allow us to conclude that intensive and extensive fattening pigs, despite many common purposes and assumptions, differ significantly from each other. Local (native) breeds are characterized by lower productivity, what reflects in the income from production, while the maintenance of these breeds allows to benefit from a larger pool of subsidies paid by the state. This is intended to encourage breeders and producers to maintain

indigenous breeds, as well as to partially compensate for the lost income in comparison to the income that could be earned by keeping pigs in intensive fattening. This, however, generates the need for increased financial outlays for production. The results of the study confirmed this correlation. Intensive fattening farms were economically more conscious, at the same time, most farms did not pay as much attention to providing increased space or handling materials for the animals. The results of the study will allow the development of model solutions for organization of animal production on family farms and the development of recommendations for these farms to improve the level of production and economic efficiency while maintaining the highest standards and improving animal welfare.

Streszczenie

Celem badań było zebranie danych i obserwacji z 20 gospodarstw prowadzących tucz konwencjonalny (intensywny) jak i ekstensywny świń w różnych systemach chowu w Polsce.

We wstępie pracy omówiono, jak kształtuje się potencjał genetyczny tuczników ras rodzimych i mieszańców towarowych. Poruszono kwestię paszy i tego jak żywienie zwierząt może wpływać na ich parametry produkcyjne oraz jakość mięsa. Ponadto skupiono się na przedstawieniu zaleceń i norm, jakie należy spełnić, aby zapewnić dobrą kondycję pozwalającą na swobodne bytowanie tego gatunku zwierząt. Na koniec przeglądu literatury przedstawiono sytuację rynkową świń w Polsce jak i zagranicą.

Pracę prowadzono w oparciu o protokół opracowany przez międzynarodowy zespół na potrzeby projektu o akronimie „mEATquality". W badaniach wykorzystano ankiety pozwalające dokonać oceny stanu fermy w zakresie: 1- zarządzania, 2 - ekonomiki produkcji, 3-środowiska jak i 4- dobrostanu zwierząt utrzymywanych w gospodarstwach rolnych. Pozyskane od hodowców i producentów świń dane z części 1-3 pochodziły z roku 2021 i pozwalały na zobrazowanie krajowej produkcji tucznika, natomiast bezpośrednie obserwacje w kojcach ze zwierzętami prowadzono w czasie wizyt na gospodarstwie prowadzonych pomiędzy czerwcem na grudniem 2022roku.

Gospodarstwa współpracujące w projekcie, stanowiły głównie średnie gospodarstwa rodzinne, w których pracowali członkowie rodzin. Zarówno właściciel gospodarstwa jak i jego pracownicy nie znali i nie potrafili oszacować i wycenić pracy własnej w gospodarstwie. W gospodarstwach ankietowanych dominował cykl/system zamknięty, konwencjonalny, intensywny. Rolnicy w większym stopniu żywili zwierzęta paszami skomponowanymi o materiały z własnej produkcji, jedynie uzupełniali surowce wysokobiałkowe, oleje roślinne i surowce pochodzenia mineralnego. Pasza z zakupu pochodziła tylko wtedy, gdy w ciągu roku brakowało zbóż. Rasy rodzime mniej efektywniej wykorzystywały paszę na kg przyrostu masy ciała. W zakresie bioasekuracji, rolnicy deklarowali, że stosują się do zaleceń, natomiast obserwacje pozwoliły stwierdzić, że nie znajduje ona odzwierciedlenia w rzeczywistości. Zanotowane urazy u obserwowanych zwierząt, wynikały z braku różnorodności w środowisku, a najmniej nieprawidłowych zachowań zaobserwowano, gdy zwierzęta były trzymane na głębokiej ściółce. Stosowane w produkcji ograniczenia wpływają niekorzystnie na behawior tuczników. Przeprowadzone obserwacje pozwalają stwierdzić, że tucz intensywny i ekstensywny, pomimo wielu wspólnych celów i założeń, zasadniczo różnią się od siebie istotnie. Rasy lokalne (rodzime) charakteryzują się niższą produkcyjnością, co przekłada się na dochód z produkcji, natomiast utrzymanie tych ras pozwala na korzystanie z większej puli

dotacji wypłacanych przez państwo. Ma to zachęcić hodowców i producentów do utrzymywania ras rodzimych, a także częściowo zrekompensować utracone dochody w stosunku do dochodów, które można by uzyskać utrzymując świnie w intensywnym tuczu. To jednak generuje konieczność zwiększenia nakładów finansowych na produkcję. Wyniki badań potwierdziły tę zależność. Gospodarstwa intensywnego tuczu były bardziej świadome ekonomicznie, jednocześnie większość gospodarstw nie przywiązywała tak dużej wagi do zapewnienia zwierzętom zwiększonej przestrzeni czy materiałów do manipulacji. Uzyskane wyniki badań pozwolą na opracowanie modelowych rozwiązań organizacji produkcji zwierzęcej w gospodarstwach rodzinnych oraz opracowanie rekomendacji dla tych gospodarstw w celu poprawy poziomu produkcji i efektywności ekonomicznej przy zachowaniu najwyższych standardów i poprawie dobrostanu zwierząt.

1 Introduction

Sales of meat in many countries have remained static or fallen slightly in recent years; for example, in the PL total meat sales fell by 6% in the last 5 years. The average consumption of meat (with off all) in Poland in 2021 was 79 kg. This is a 1 kg decrease as against in the 2020 year. This situation has caused a reappraisal of the factors which influence the appeal of meat to consumers, which together constitute ‘quality’. Today, consumers are looking for meat that looks good in shops, is tasty and prepared with animal welfare in mind. This motivates scientists and pork producers to seek solutions that improve the quality of meat and the pork production process. In addition, consumers are increasing more and more attention to the environment in which the animals were kept and the way they are slaughtered. Ecological farms are becoming more and more popular. Providing slaughter animals with as much freedom as possible is becoming an increasingly common challenge for farmers. The basic principle that consumers follow is to be sure that the meat they buy was given from an animal that lived in accordance with the principle of ensuring 5 freedoms.

Many factors influence the quality of pork including by the sex of the animals, age, diet and type of use, the environment in which they are kept and welfare. Furthermore, the main factor influencing the quality of meat is the stress that the animal experiences during its life.

Conventional pigs breed, as a result of intensive breeding work, are characterized by fast growth and are susceptible to stress factors, which impairs their welfare. Whereas native breeds are characterized by slower growth, greater resistance to disease, better use of high-fiber and low nutritional value feeds.

The aim of the study is surveys extensive husbandry factors in relation to intrinsic meat quality, through data collection on conventional, free-range. In this work, native and conventional breeds were compared in different housing systems in different parts of the country. Independent farmers answered the economic, environmental and welfare surveys. Moreover, on the farms behavioral tests were performed used of animals.

This study was realized supported by the Programme: Linking extensive husbandry practices to the intrinsic quality of pork and broiler meat ", acronym "mEAT quality” no: 101000344 which the aims to provide consumers with quality pork and broiler meat, by developing novel solutions that address societal demands, environmental concerns and economic needs on farm and in the chain.

2 Review of the literature

2.1 Genetics

The potential influence of factors over the genetic on quality may be more or equal. The maintenance of certain pursuit, the reduction of (genotype: selection of animals for reproduction of the environment and maintenance conditions) and the treatment of animals prior to and during slaughter are all ways to enhance the quality of the generated activities. It is feasible to create goods with higher utility values using raw materials of higher grade. The genetic influence on pork quality comprises differences among breeds as well as differences among animals within the same breed [Rosenvold and Andersen, 2003]. Suitable pig breed crossover, genome manipulation, and appropriate choices that provide the choice of the highest-caliber individual features that define the level of quality [Rosenvold and Andersen, 2003].

In Poland, the breeding program for pigs has been prepared by the Polish Pig Breeders and Producers Association and runs a breeding program for the 13 breeds of pigs.
For the breed Złotnicka white and Złotnicka spotted breed, the breeding program is carried out by the University of Life Sciences in Poznań. On the other hand, the National Research Institute of Animal Production keeps herd books for the synthetic breed of pigs: line 990 [Szwaczkowski et.al., 2019].

In our country three native breeds are reared: Puławska pig, Złotnicka White and Złotnicka Spotted. These breeds are renowned for producing very high-quality meat that is used to create traditional Polish meat dishes. This breed's meat is juicy, soft, and marbled in a distinctive manner [Janiszewski et.al., 2015] The Puławska breed is characterized by the lowest acidity of muscle tissue, but the meat is the most delicate in taste. On the other hand, all Polish native breeds have the lowest meat drip loss. The darkest meat and the highest protein content are found in the Złotnicka Spotted breed. The functional and physicochemical factors of Polish native breeds are higher than in the case of commercial breeds [Bogucka and Kapelański, 2016]. Crossing the Złotnicka spotted breed with the Polish Landrace and Duroc breeds contributes to the improvement of the slaughter value of porkers and does not lower the quality of the products obtained from their meat [Janiszewski et.al., 2015].

The heterosis phenomenon underlies the production of high-quality meat from native or commercial breeds. This is the occurrence of an increase in the anticipated quantitative features in first-generation (F1) heterozygous hybrids produced by mating homozygous parents. Right now, Poland uses two different kinds of cross-breeding pigs: those for porkers and those for reproduction [Babicz and Kalinowski, 2019]. The most prominent feature of meat that connects

all pig lines and breeds is the intramuscular fat content (IMF). IMF affects the tenderness of the meat, juiciness and taste. Breeding work led to the production of pig meat with a low fat content and a high lean meat content [Krzęcio-Nieczyporuk et.al., 2019]. The highest IMF content is found in the Duroc breed, and at the same time it is the breed with the highest marbling of meat [Szulc et.al., 2013]. The maximum color brightness and cooking loss values were seen in landrace pigs [Migdał et.al., 2007]. Greater fleshiness, thinner lard, and more intramuscular fat are characteristics of three-racial hybrids of the Polish Landrace (Duroc, Pietrain) [Grześkowiak et.al., 2010].

2.2 Feeds

It is well known that animal dietary regimen greatly affects meat colour, and the fatty acids profile of meat as well as their flavor.

Feed availability is crucial for fattening. Two to four feeding phases can be identified while fattening pigs. The starter, growth, and finisher phases make up the most common feeding in polish model. The supplied feed combinations different from one another in terms of their nutritional and energy content in phrases [Grela et.al., 2019]. Additionally, feed additives enhance the amount of bacteria that produce acid, which benefits the immune system. [Rekiel et.al., 2008]. They enhance the feed's flavor and quality, which raises productivity and, consequently, profits from the production of pigs. There are additives such as: probiotics, symbiotic, prebiotics, herbs, oils, exogenous enzymes, acidifiers, short and medium chain fatty acids [Jankowska 2022, Nowak et. al. 2021].

Pigs are a species with a quick rate of growth. The energy and protein requirements of fattening pigs result from their growth potential as well as their feed intake. This is because of the genetic value of animals passed down from the F1 generation. The animals growth an average of 750-1050g per day when they are fattening up, between 30 and 110 kg. Noticeable is an increase in body weight of approx. 1 kg each day in breeds known for their fast daily weight growth (commercial breeds and hybrids) and feed conversion ratio (FCR) per 1 kg of body weight is 2.5 kg [Knecht et. al. 2019]. At the age of 165–180 days, these fattening pigs achieve the slaughter weight [Grela 2001]. On the other hand, native breeds of pigs are fattening longer than commercial breeds. Usually the fattening is carried out to 140-170 kg. Daily gains are high for native breeds ranging from 550–600 g per day [Babisz et.al. 2017]. Although energy is required to maintain muscular growth, too much of it can lead to an increase in body fat. Energy limitation causes leanness to rise but marbling to decrease. Pigs develop slower,

generate fatter carcasses with greater marbling, and produce less protein if their intake of amino acids is inadequate to maximize the rate of protein deposition [Pettigrew and Esnaola 2001].

Extensive of nutrition of native breeds is based on the use of forage. The forage that can be fed to fattening pigs includes, for example: whole-plant silage from clover and grass, whole-crop silage from oats, vetch and lupine, silage with whole crops of barley and peas, clover and grass hay, fodder beet.

However, it should be noted that is that the smell, taste, texture and dry matter content affect the time and level of interest feed [Olsen et.al. 2000]. The Złotnicka breed fed with silage and the addition of acorns is characterized by high-tasting meat due to the higher fat content in the meat, which is the flavor carrier [Szynder-Nędza et.al. 2021]. The advantages of extensive nutrition include the use of local and farm resources, and even pastures and paddocks. A low-protein diet used in native breeds increases fat storage in animals but allows for savings in feed costs [Tejeda et.al.2020]. Nutrition based on natural, unprocessed feed is more complicated due to the variability of chemical composition and nutritional value of farm feed, moreover, it is difficult for the farmer to prepare feed for feeding, transport and above all, seasonality of feed components [Szwaczkowski et al. 2019]. On the other hand feeding fast growing pigs, requires the use of complete mixtures with a high concentration of protein and energy. They usually include such feed components as: wheat, triticale, rye, corn, wheat bran, soybean meal, rapeseed meal. The most common method of intensive fattening is *ad libitum* feeding, during which fattening pigs have free access to feed all the time. Also, straw as an additive supplement the diet is used in both native and commercial breeds. It is an element enriching the environment, it shortens the time inactivity and time devoted to aggressive behavior [Kozera et.al. 2009].

2.3 Welfare

Welfare means a state of balance of physical and mental health maintained in conditions of complete environmental harmony. Described by Hughe's and Duncan in 1988, the definition of welfare remain till to this day [Hughe et. al.1988]. The breeder reaches the welfare level when the animals have the ability to deal with environmental factors while maintaining homeostasis [Broom 1986], and when the animal can adapt to environmental conditions without suffering [Carpenter 1980]. The main animal welfare directive is the principle of the “five freedoms” [Council Directive 98/58/WE of 20 July 1998]. According to the animals should be free from:

1) Thirst and hunger

2) Physical and mental discomfort
3) Pain, diseases and injury
4) Fear in a relationship with humans
5) Should befree to distress and fear

Due to the extensive definition of welfare, it is difficult to clearly define the on-farm evaluation protocol, but the most common division is into health, physiological and behavioral indicators. They were designed on a multi-level scale defined from low to high (Table 1).

Table 1. Indicators of the level of welfare of farm animals [Broom 1997]

Low level of welfare	**High level of welfare**
Incorrectly estimate of adaptability in stressful situations	Displaying all forms of normal behavior
Incorrectly estimate of the possibility of manifesting natural behavioral responses	Keeping normal physiological indicators
Behavioral pathologies - stereotypies	Maintaining normal behavioral patterns
Cannibalism/drug self	
Damage to the body	
Immunosuppression	
Disease	
Reduced ability to grow and develop	

The guiding idea for evaluating wellbeing is to avoid seeing the demands of the image through the lens of human needs. In addition, the assessment takes into account the health condition of the animals and their productivity. Healthy animals with a high level of productivity (daily gains) have a high or very high level of welfare [Kondracki et al. 2014]. Pigs are a very sensitive species, especially those kept in a production environment, and they need specialist attention to ensure their physical and behavioral welfare.

The innate factor of the organism showing the level of welfare is the animal's response to stress. It is the immune system's response to stress factors, otherwise known as stressors. There is a distinction between physical, chemical and psychological stressors [Skwarło-Sońra et al. 2015]. There are one-off and short-term and long-term factors, so-called chronic stress. Pigs, depending on their genetic sensitivity to stress, are classified as stress-sensitive or insensitive to stress [Skwarło-Sońra et al. 2015]. Factors causing fear in pigs:

- using treatments on the body of animals;
- regrouping;
- being outside the herd;
- noise;
- change of the pig house microclimate;
- human aggression towards animals;
- aggression among the herd [Kondracki et al. 2014].

These disorders lead to the emergence of stereotype behaviors. Sequential repetition of mouth movements at least 3 times in a row without having any obvious function is defined as stereotypies. There are also motor stereotypies as "playing" with pen elements, bedding or equipment such as chains. Stereotype is a unit that can fade away by removing the causes of boredom or stress in the pen [Rousing 2022].

Thermal and humidity conditions are another stressful factor. Pigs experience very high stress when thermal values are disturbed in the pigsty, due to the specific difficulty with thermoregulation. Pigs with varied development cycles require a wide range of dwelling temperatures, although animal behavior is the same regardless of technical group. Table 2 shows the animals' behavior depending on the ambient temperature [Barej 1991].

Table 2. The influence of low and high ambient temperature on the behavior of animals [Barej 1991]

Temperature under 15ºC	**Temperature over 20ºC**
Grouping of animals	Avoiding grouping of animals
Higher herd mobility	Low physical activity
Hibernation	Drinking more water
Virus infections	Less feed intake
	Soaking in water
	Looking for shade and coolness

Providing a high level of welfare is based on preparing the interior and exterior of the piggery to the requirements of the species of animals kept. Biosecurity plays a key role as it protects animals against the introduction of disease entities by humans. Among pig farmers, biosecurity outside principles is known and followed, such as:

- adapted farm location;

- he use of nets in windows and doors of buildings, disinfection mats before entering the farm and before entering buildings;
- to apply quarantine for newly purchased animals;
- using a register of entries and exits on the farm (including restriction of access by people not related to the farm);
- providing biosecurity training for employees;
- the observance and use of clean litter;
- securing the piggery against rodents, wild and accompanying animals;
- fast disposal of dead animals [Sinkiewicz 2020].

On the other hand, the biosecurity inside of the piggery interior is based on following the rules:

- individual care for the health of each animal and the whole group;
- rooms disinfection;
- rule “the whole room is empty, the whole room is full”. It means that each pig house must be completely emptied of all animals at the same time. It is unacceptable to leave a few animals in the building and introduce more animals. A new batch of animals may only be introduced after the room has been cleaned and disinfected and after a few days' break [Konarkowski 2012]);
- strict adherence to the rules by all pig farm workers.

The application of the principles of internal and external biosecurity ensures that animals are free from diseases, thus increasing the level of animal productivity [Soszka 2020].

2.4 Pen space and equipment

In Poland, there are 8 system for fattening pigs:

- on fully plastic slatted floor (presented in picture 1);
- fully metal slatted floor (presented in picture 2);
- on partially bedding floor (presented in picture 3);
- on thin fully bedding floor (presented in picture 4);
- on deep fully bedding floor (presented in picture 5) [Winnicki et al. 2011];
- on the enclosure (presented in picture 6);
- in the pasture (presented in picture 7);
- mixed system inside and outside.

Despite the employment of several strategies for pig fattening, the area permitted per animal is the true measure of breeding intensity [Welfare Quality 2009]. In Poland, the minimum spatial

requirements for fattening pigs are presented in the table 3. In addition, farmers can receive a state subsidy for each fattening pigs if they apply the increased welfare program presented in the table 4.

Table 3. Minimum areas for fatteners [Regulation of the Minister of Agriculture and Rural Development of February 15, 2010].

Body weight (kg)	**Area per animal (m^2)**
30-50 kg	0,40
50-85 kg	0,55
85-110 kg	0,65
over 110 kg	1,00

Table 4.Minimum areas with increased welfare for fatteners s [Rural Development Program 2014-2020].

Body weight (kg)	**Area per animal (m^2)**
30-50	0,48
50-85	0,66
85-110	0,78
over 110	1,20

The placement of drinkers and feeders should take into account the density and design of the pen. Fatteners should have constant access to feed and water. Water should flow at a rate of 1-2 liters per minute, it is important because the fattening pigs consume water up to 10% of their body weight [Knecht 2019]. In accordance with the Regulation of the Minister of Agriculture and Rural Development of February 15, 2010, that in pen should be one installed drinker for every ten finishers. The layout should be straightforward, dependable, practical, and easy to maintain. Pigs must be housed in cages with at least 40 lux of light intensity for eight hours each day, the noise level must not exceed 85 dB. in accordance with the Council Directive 2008/120 /WE of 18 December 2008.

Picture 1. Fattening pigs on fully plastic slatted floor (Author: Zofia Domke).

Picture 2. Fattening pigs on fully metal slatted floor (Author: Bernadetta Gwoździk)

Picture 3.Fattening pigs on partially bedding floor (Author: Przemysław Forszpaniak)

Picture 4. Fattening pigs on thin fully bedding floor (Author: Bernadetta Gwoździk)

Picture 5. Fattening pigs on deep fully bedding floor (Author: Bernadetta Gwoździk)

Picture 6. Fattening pigs in the enclosure (Author: Bernadetta Gwoździk)

Picture 7. Fattening pigs in the pasture (Author: Bernadetta Gwoździk)

Currently, the breeder is in charge of making sure that pigs have a high level of life, but it is also a factor that affects the output. Numerous stresses brought on by poor housing conditions and handling of the pigs are significant environmental variables that deteriorate their health. These include, among other things, an excessive number of animals compared to the available space, temperatures in livestock housing that are too high, stress from animal transportation and slaughter, no variety of toys and a lack of access to feed and water [Kozera 2017].

2.5 Environmental enrichments

Pigs are a species that differs from the others in that their minds are extremely flexible. They pick things up extremely quickly, remember them, and develop strong attachments to individuals. For the sake of their mental health, they demand that the owner create an atmosphere that lives up to their standards. There must be enough of livestock in the ecosystem. Without them, pigs feel less happy, are more frustrated, have to adjust how they go about their everyday lives, and even exhibit conduct that is aberrant for their species, [Nowicki 2021]. Due to the species specificity of pigs, providing pen enrichment is a legal requirement in the EU [Weerd 2019]. In Poland, these rules are regulated by directive 2008/120/WE, which regulates enrichment materials can be used in pen. According to the directive, straw, green fodder, miscanthus, and root vegetables are the most matched for pigs. This information is helpful in determining the use and appropriateness of the enrichment materials. The main goal of

enriching the environment is improvement the functioning of animals in captivity [Weerd 2019]. Table 5 shows characteristics of effective pigs' enrichments.

Table 5. The main characteristics of effective pigs enrichment [Weerd 2019].

	Possibility of different behavior	**Reason to use in a pen**
Investigable	The possibility of manipulating and testing the materials by the pig snout	Still interesting to a pigs
Manipulable	Moving materials, exploring structure and appearance	Available in sight of pigs
Chewable	Manipulate by biting and chewing	Available to all animals in pen
Edible	Roughage (Feed is not regarded as enrichments)	Minimizing the risks of injury or disease-causing agents.

According to Directive 2008/120/WE, elements enriching the environment and stimulating in animals, the willingness to manipulate them should have the following three characteristics:

- edibility (ideally if they contain nutrients that have a beneficial effect on digestion),
- possibility of chewing and rooting,
- destructibility.

Animals get bored with manipulation objects quite quickly. It is also important the height of the toys hanging. Pigs prefer to manipulate on objects below their snout. Those that hang at its height are not noticed. Best height is 5 cm above the ground, but then unfortunately they get dirty faster. If the pigs are kept litter less, environmental enrichment material should be fed in special trays. Pigs reject fecal contaminated items and show no interest in them (Bracke 2007). Environment enrichment materials, that stimulate most of the behavior related to exploring the environment, are best for tail biting prevention (Studnitz et al. 2007). Due to the need to manipulate, farmers are looking for various innovative solutions that can be used in pens. Therefore, in the pens can observe: suspended chains (presented in picture 8, plastic bottles (presented in picture 9), balls or tires (presented in picture 10).

Picture 8. Fattening pigs playing with chains (Author: Bernadetta Gwoździk)

Picture 9. Fattening pigs playing with plastic bottle (Author: Bernadetta Gwoździk)

Picture 10. Fattening pigs playing with a suspension tire (Author: Anita Zaworska-Zakrzewska)

Picture 11. Fattening pigs playing with a indigestible chewing element (Author: Bernadetta Gwoździk)

2.6 Economic sustainability

The prospects for the development of the Polish pig sector are not the most favorable. The troubled situation in Poland is influenced by:

- spread of African Swine fever Virus (ASF), viral sepsis, acute or chronic swine disease. It is characterized by a very high mortality). In 2020, there were 103 outbreaks of the disease, in 2021 - 124 in 2022 - 14 (as of October 16) ,
- too low economic awareness of pork producers,
- plight worldwide due to the outbreak of the pandemic COVID-19 (pandemic of the infectious COVID-19 disease caused by the SARS-CoV-2 coronavirus. It started as an epidemic on November 17, 2019, in Wuhan City, and March 11, 2020 was declared a pandemic by the World Health Organization (WHO)).
- grain shortages due to the war in Ukraine (started on February 24, 2022, by the Russian Federation, constituting an escalation of the war that has been going on since 2014),
- soaring prices of protein components,
- increasing popularization that a plant-based diet is richer in nutrients [Sadura 2022].

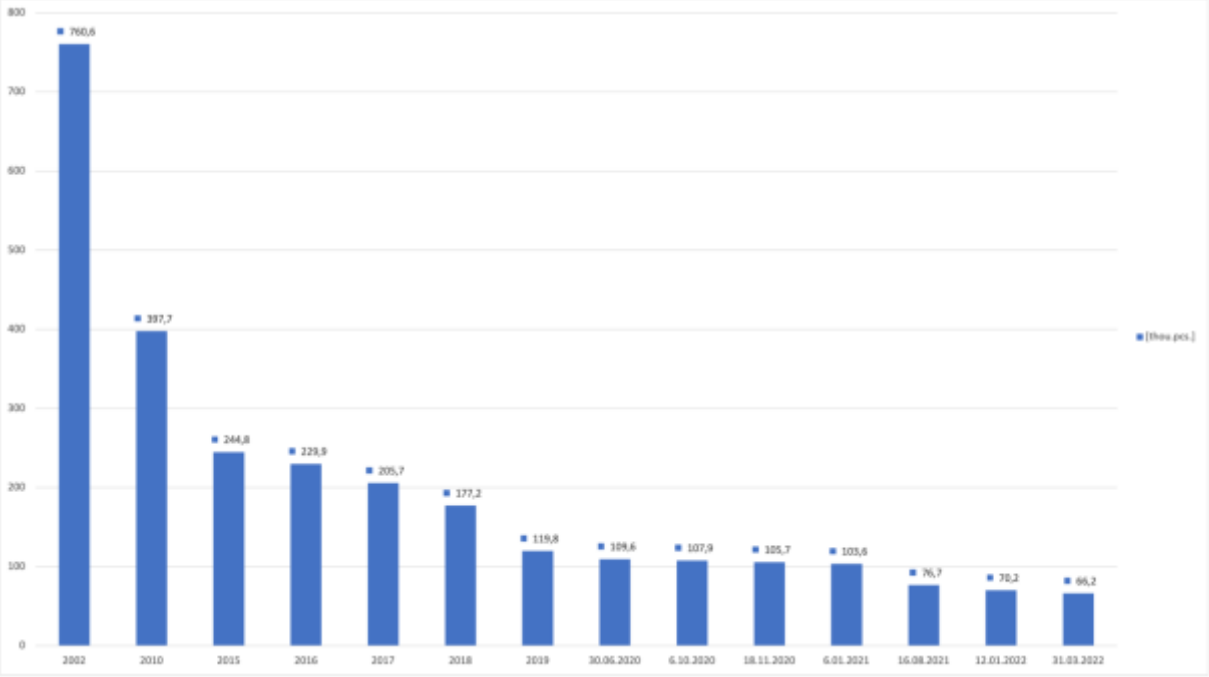
These factors contribute to the decline in the number of pigs in Poland and also in the world.

For the profitability of pork production, the prices should be higher. The minimum purchase price for pork in 2021 is PLN 3.80/kg to a maximum of PLN 5.00 / kg.in October 2022 the price is PLN 6,40/kg up to a maximum of PLN 7.60 / kg (prices are based on live weight of fattening pigs). The pork market the price all the time is very unstable. The situation in the world is also working to the disadvantage of pork producers. The armed conflict in 2022 led to record increases in the prices of feed materials. They constitute the basic cost (70%) of livestock production [Pepliński 2022]. The instability and predictability of feed and market prices are not the only reasons in Poland that lead to a decline in the number of fattening farms. Other reasons given by farmers to stop production are: the lack of effective actions by the government to reduce ASF, the costs of modernization of production, the green order introduced by the government, the growing percentage of people switching to meat-free diets, the growing number of intermediaries in the production of pork, no depreciation for producers with strong price fluctuations [Soszka 2022].

There is an unfavorable decline in the number of pigs as of March 31 According to the Agency for Restructuring and Modernization of Agriculture 66 200 herds of pigs have been registered in Poland (presented in Figure 1). According to the data at the turn of 2021/2022, 51

herds was closed daily. Which means that the average herds in Poland decreased by 5.7% by years 2021/2022. The main reason for this was the outbreaks of ASF. It was one of the reasons influencing the profitability of pig production. Small farms are becoming less common in Poland and across the world, while massive industrial farms-which are still relatively uncommon—are expanding [Watanabe 2021]. The solution to this situation are producer groups that are gaining more and more interest in Poland. Single, small farms merging into group gain recognition in the eyes of strong competition as a noteworthy company. The farmers' association cannot sell the goods on different, better conditions, but it can receive a larger amount of subsidies for sale, which are funded by the Agency for Restructuring and Modernization of Agriculture [Soszka 2022].

Figure 1. Change in the number of pig herds in Poland in 2002-2023 for Source Central Statistical Office.



Observations carried out within the project under the acronym "mEATquality" allow to assessment the situation of fatteners reared on domestic and commercial farms. All animal keeping systems in the country will be analyzed.

3 Aim and hypothesis

3.1 Aim

The aim of the study is to collect data and observations from Polish extensive and intense farms producing porkers in various housing systems. The study used questionnaires on economic, environmental and animal welfare conditions. In addition, direct observations of the behavior and welfare of fattening pigs in pens were carried out.

3.2 Hypothesis

Different housing systems and conditions in the pigsty will affect the results of observations in animals. Additionally, the difficult situation and changing frequently on the pork market forces producers to apply changes in pig housing systems, as well as changes on use feed. These changes adversely affect the behavior of fattening pigs.

4 Materials and methods

4.1 Choice of farms

The project "mEATquality" assumed carrying out 20 surveys in farms in Poland keeping fattening pigs. Farmers and farms willing to cooperate in the project were searched for through an advertisement in a trade newspaper, web pages and through the use of previously established cooperation with the Poznan University of Life Sciences in Poznań. A total of 22 surveys were carried out, while 20 family farms were qualified for the purposes of the project and for the analysis of the master's thesis. All economic and environmental data were collected for 2021. The welfare protocol, on the other hand, concerned ongoing observations and was performed in 2022 - status on the day of the farm visit.

In Poland on choice of farms and data collection was carried out by a team of 4 people (PULS team) (presented in picture 12): from the left PhD. Anita Zaworska-Zakrzewska, PhD. Małgorzata Kasprowicz-Potocka, MSc. Dagmara Łodyga and Eng. Bernadetta Gwoździk.

Picture 12. Data collection team (Author: Dawid Dobruchowski)

4.2 Data collected

One comprehensive protocol consisting of 3 parts was created for the purposes of the surveys. – The first two were conducted in the form of an approx. 3-hour interview with the

farmer (owner of the farm), regarding part 1) management and economic and 2) environmental. A detailed questionnaire of questions asked to farmers was placed in attachment (no 1.).

During the first part of the analysis of the protocol, the interviewers asked general and specific questions that were included in the survey and, based on the received answers, recorded data or calculated and together with the farmer the results for the farm. The second part evaluating animal welfare was conducted in a piggery on selected animals by a team PULS. Immediately after the first part questionnaire with the farmer, the team started direct observations in the pens (animal welfare protocol). The team kept min. 72h break between data collection on farms. Before entering the piggery, the team changed into costumes providing biosecurity protection. The observations were carried out on 100 animals weighing between 50 and 90 kg.

The first step in all piggery was avoidance test. Two members of the team entered the room with the animal pens. For a minute, both people watched the pigs' behavior, then one of them went directly to the pen where for about 1 minute walked around to observe the number of pigs that avoided contact. After completing the task, proceed to the next steps strictly defined by the prepared protocol Questionnaire animal welfare mEATquality project for the PULS (attachment no 2) .

4.3 Data analyzed

The collected data from the questionnaires were entered into the Excel system, which was prepared by the "mEATquality" team from Italy, Spain and Denmark. The answers obtained from the questionnaires were compared and the relationships observed on farms were found. The descriptive statistics (mean, minimum and maximum value, coefficient of variance, standard error) were used to characterize number data, the remaining data were presented graphically and on charts. To facilitate the transfer of information in attachment (no 1 and 2) was placed protocol in English version.

5 Results

5.1 General data

The project with the acronym "mEATquality" worked with farms that produced fattening pigs in open, closed and housing systems located in the central and western part of the country (Picture 13). The average farm size was 128.05 ha. Half of these farms were located in the pink zone and the undeclared zone (Figure 2).

Picture 13: Locations of farms participating in the project (protocols).

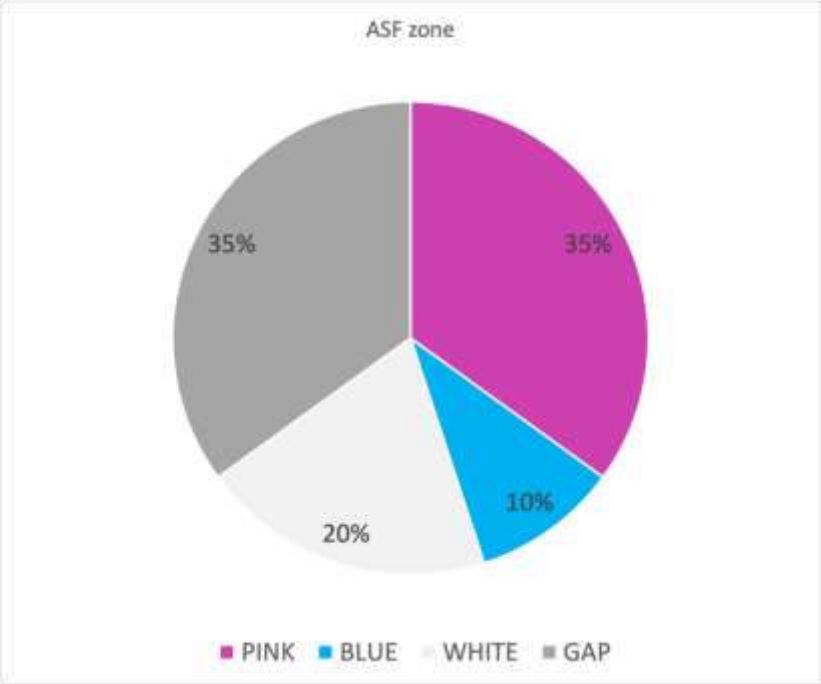
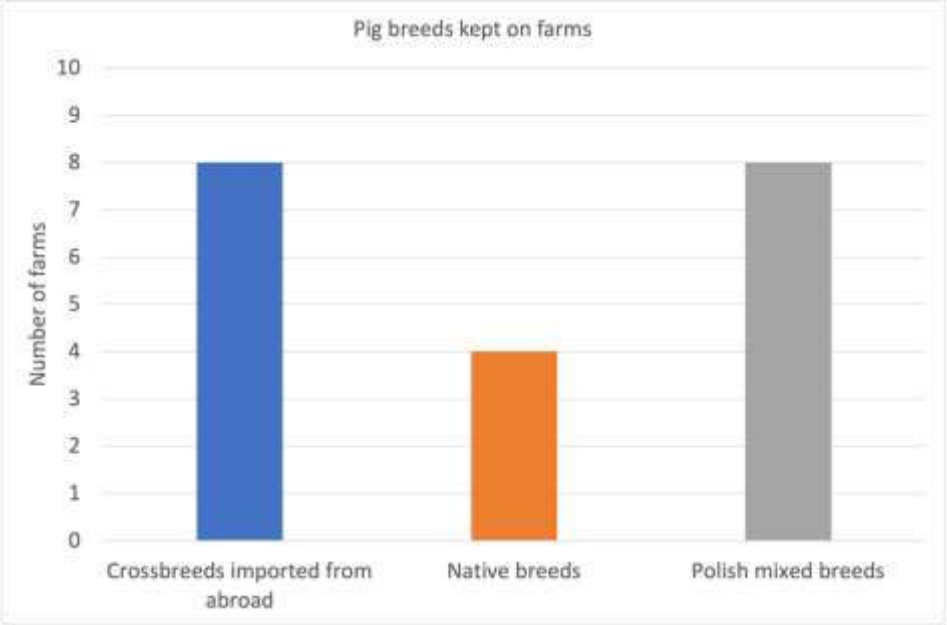


Figure 2. ASF zones in which the researched farms were located.

Closed system accounted for 60%, open system 30% and mixed system 10%. The conventional intensive system was used in 16/20 farms. The extensive system was applied in 3/20 farms and one used an extensive organic system.

Observations were made of all breeds that are kept in the analyzed territory, such as: Zlotnicka spotted, Zlotnicka white, Pulawska, Polish Landrace, Polish Large White and crossbreed (Figure 3).

Figure 3. Pig breeds kept on farms



5.2 Management and economic protocol

Some of the questions about the economic issue of farms were the most controversial for the recipients. The data presented in the table below usually estimates. Few of the farmers were able to accurately answer the questions asked. It was observed that the smaller the farm, the less attention was paid to collecting information, e.g., on income and outcome of the farm. After conducting the whole survey, the owners were surprised how much they actually spend on the production of fattening pigs.

5.2.1 Production and inventory

From the study group of 20 farms, trend was observed among farmers. They try to invest as much as possible and develop their production. Most often, investments concerned the development of farm buildings and investments in photovoltaic panels. 7/20 of them had renewable energy sources. The remaining part of them declared their willingness to invest in the near future. The farm has always had buildings and vehicles insured. This is also a group of people who used pharmacological help, but most often without the intervention of a veterinarian. Remedies are used by the owners when the disease is observed. In the production cycle, rearrangement of animals is avoided. They are used only when necessary. An exception was also a 4 farms free of antibiotics, they did not use supportive drugs. Animals arrived on farms with their tails and tusks cut off, but there were also individuals with long tails. The animals had no interference in the free-range farm.

Zootechnical advice was offered to farmers by the nearest Agencies for Restructuring and Modernization of Agriculture. However, farmers used their own knowledge, or acquired it at major agricultural conferences. Most of the respondents had higher education in agriculture or zootechnics.

Observations were made on the average of kept animals for the entire research group was 1885 animals. The average body weight of a fattener was 75.3 kg.

One of the surveyed farms ran its own meat processing plant. 15/20 farms settled accounts with the slaughterhouse according to hot carcass weight. 20% of them were paid for live weights. Dies during transport to the slaughterhouse did not happen to farmers at all, or very sporadically. Manure and slurry obtained from animal production were always used after crop production.

Table 6. The economic and management performance of farms

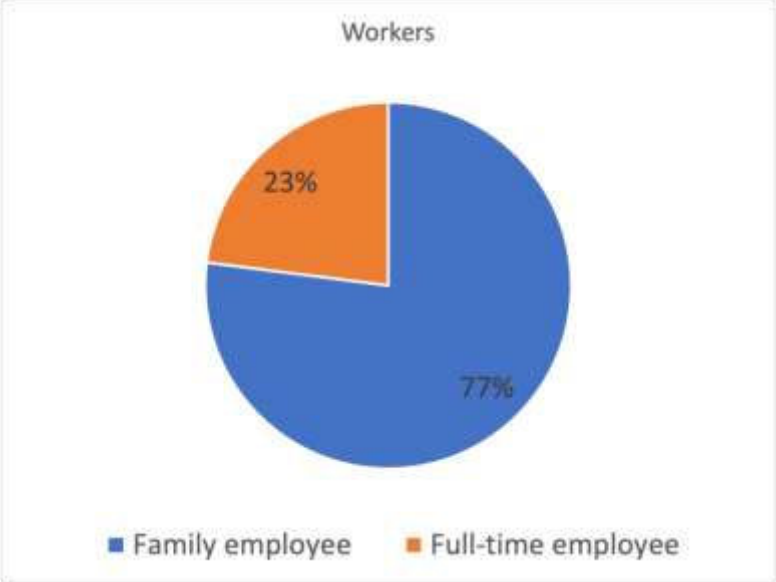
Item	Mean	Min.	Max.	SD
Number of pigs January in 2021	669	40	4000	932
What was their average body weight? (kg) January 2021	75	26	125	24
How many pigs could you have in December 2021? (n.)	662	28	4000	937
What was their average body weight? (kg) December 2021	74	30	110	24
How many piglets went to the fattening house? (n) 2021	2105.3	60	11000	2775.7
Purchase price piglets (PLN/pcs.) 2021	228.87	125	370	79
Overall fattener mortality (%)(current)	1.7	0	6	1.8
Average daily weight gain (g/day) (current)	967.5	375	1800	333.6
Number of pigs (current)	652	41	4000	947.5
Subsidies for endangered/rare breeds (PLN/year) 2021	700	0	1800	797.4

Min.- minimum; Max.- maximum; SD- standard devision

5.2.2 Labor

Research has shown that the vast majority of employees are those employed by relatives presented in figure 5. On average, they spend more than 60% of their working time caring for animals and the buildings they live in People who worked on their farms were not able to answer the question about how they value their work in an hourly rate. When asked to estimate these costs, the most common answers were in the range of PLN 10 to PLN 20. There were men and women working on the farm, but they mostly did record-keeping work. These employees also have to prepare feed for animals in their tasks.

Figure 4.Workers employed on the farm.



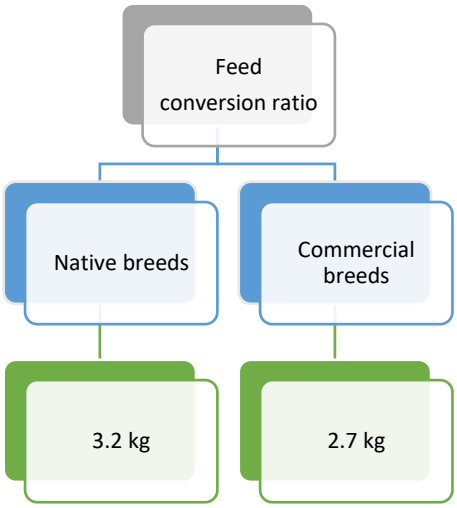
5.2.3 Feeding

40% of the surveyed farms do not separate the feeding of fatteners into feeding periods, while 45% of them divide the feeding into 2 feeding periods and 10% into 3 feeding periods. 17/20 farms produce fodder based on the cultivation of cereals from their own fields, but other farms have all their grain from purchases. 85% of the respondents buy grain only when their own stocks are exhausted. Cereal products are purchased locally. 100% of the respondents fully buy plant protein materials for pig nutrition. Oil components as well as vitamin components and premixes are 100% obtained from purchases that are not local. Native breeds were characterized 0.5 kg/kg a higher feed conversion ratio, than commercial breeds (Figure 6). The animals were mainly fed dry due to the most commonly used feed delivery system, i.e., tubomats, however, the feed was delivered dry and the animal had the opportunity to mix the

feed with water (presented in picture no.14). The water was in direct contact with the feed. The only exception were animals fed using troughs, then the owner mixed feed with water or whey.

Picture 14. Feeder with the possibility of mixing dry feed with water.

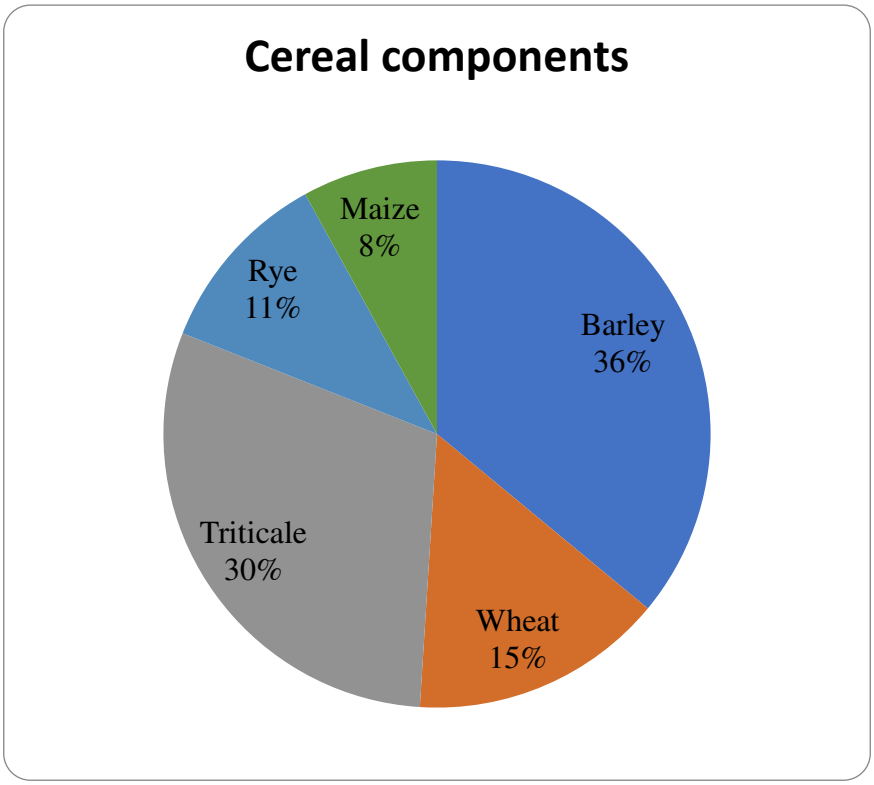
Figure 5. Feed conversion ratio.



85% of the grain products used to feed the animals came from own production. The most commonly used components are shown in the diagram no.4. The demand for protein was supplemented by farmers, most often using soybean meal interchangeably with rapeseed. The farms with the smallest number of animals kept and the farm with free choice used feed components that came from local production. These were oilcake, faba bean, whey, potatoes, green fodder. Such feeds were not used on commercial farms. Premix and mineral-vitamin

feeds were used in 19/20 farms, excluding free-range farm. Animals were fed ad libitum in 17/20 farms under study. The exception was the smallest of them and free-range ones. In 85% of the farms, the feed was served dry, and the animals had the opportunity to mix it with water due to the types of feeders used in them.

Figure 6.The most commonly used cereal components [in %].

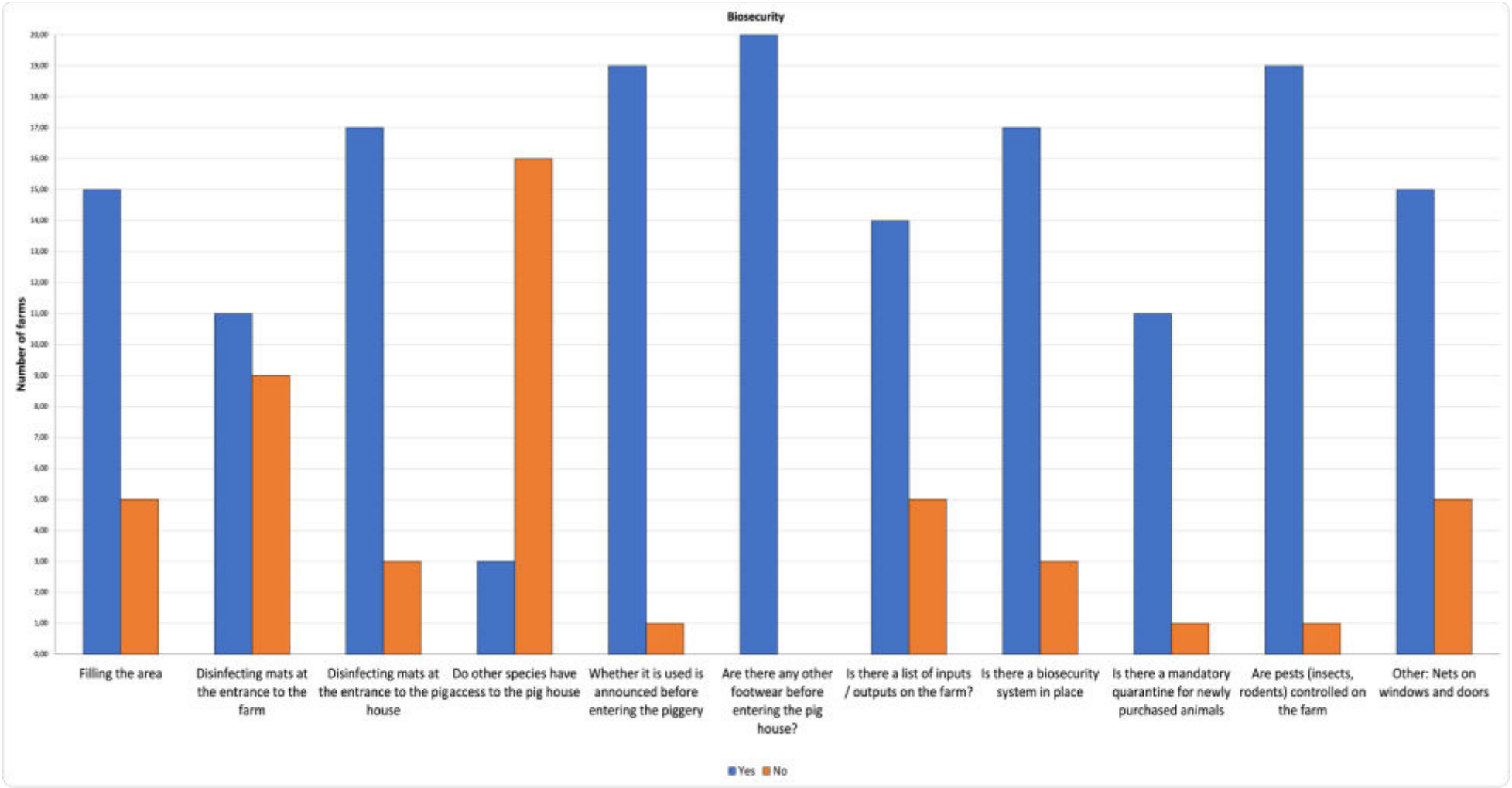


5.3 Environmental protocol

The people who gave the interviews were asked to answer what kind of biosecurity they use on the farm. Their answers are presented in figure no. 7. However, the most common responses were those that made the interviewers think they wanted to hear.

During the observation on the farm, it was verified whether the declared biosecurity measures are true. In 2/20 of the farms, the book of entries and exits was actually kept. It happened that the nets used in the windows had too large mesh, which meant that the birds had access to the pigs' pens (shown in the picture 15). It has also been observed that domestic animals have access to the fattening pigs.

Figure 7. Respondents' responses on the issue of biosecurity on the farm



Picture 15. Nets on the windows in the pig farm (Author: Bernadetta Gwoździk)

5.4 Animal welfare protocol

5.4.1 Behavior and animal healthy

All animals in analyzed farms (mean 94 pigs in farm) were mostly healthy and usually showed behavior normal for their species. After entering the pen, the animals abruptly moved away from the observer, but after a while they returned and sniffed the human. After starting to walk around the pen, the animals followed the man step by step (presented in picture no.16). Only sick animals did not follow the group. This happened only on one of the farms.

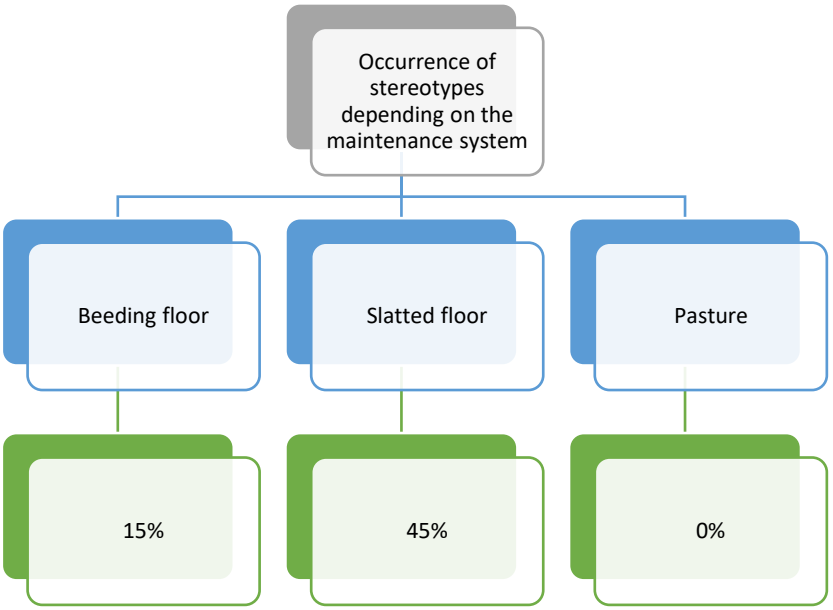

Picture 16. Doing an avoidance test (Author: Anita Zaworska-Zakrzewska)

Farmers maintained groups similar to each other by weight on every pen. In one of the farms there was a higher number of runts. The runs were observed in 8 pigs of all farms. This was due to the lack of vaccinations during the piglet period. The farmer decided to vaccinate a smaller number of pigs due to the need to reduce the cost of animal production.

5.4.2 Stereotypes

It was observed that the most abnormal involuntary, repetitive movements with a specific pattern were observed in the slatted system. In 3/6 of the farms, it was observed that despite the use of straw as an environmental enrichment, the pigs still showed the behavior of motor stereotypes. Fatteners living on slats most often exhibited stereotype behavior (presented on picture 17), however, this is not a constant relationship. The stereotypes were not based on the breed of pigs. Stereotypes have not been found in any fattener kept in the pasture.

Figure 8. Stereotypes depending on the maintenance system



Picture 17. Movement stereotypies - mutilation of the body, by rubbing against the wall (Author: Bernadetta Gwoździk)

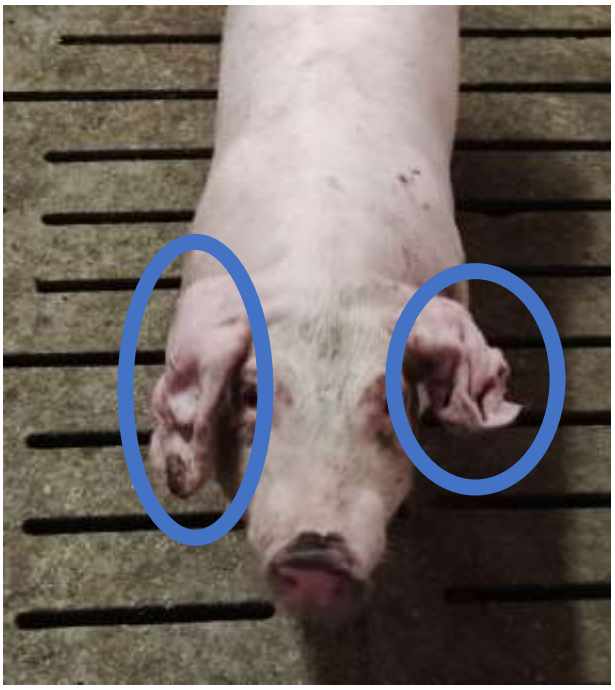
5.4.3 Toys

Single of pigs were aggressive in the pens, while most often the animals used the available toys in the pens. The most often in the pens were found chains, then plastic bubbles, then tires and licks. In 6/20 farms animals were kept on bedding, then it was an element of environmental enrichment, but additionally the animals had chains. Nevertheless, straw was a more attractive element of manipulation. The farm that kept its pigs in the paddock did not use additional environmental enrichment. The animals used what they had in the enclosure (photo no 18). It was observed there that fattening pigs always walk around the paddock in their previously developed ways.

Picture 18. Free-range housing (Author: Bernadetta Gwoździk).

5.4.4 Clinical observation

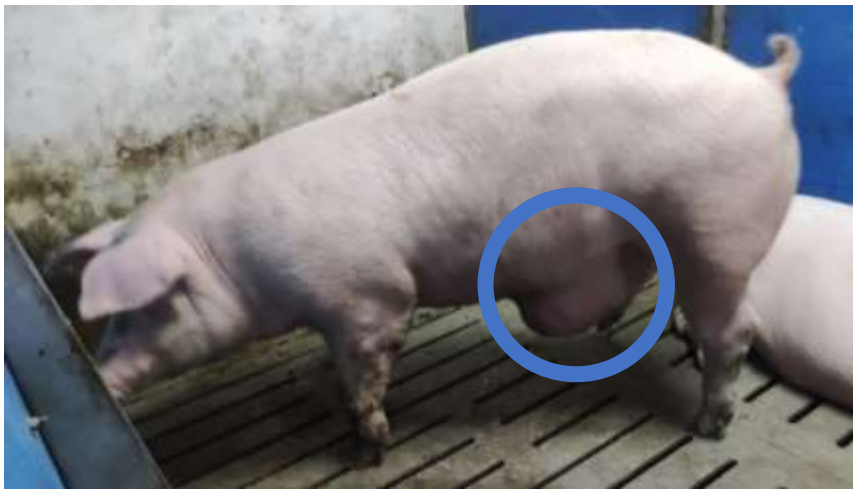
In all farms, were observed 1885 fattening pigs. During the observation, no sunburns or ectoparasites were observed in any of the farms. less than 1% of them had a hernia, most often when it happened the animal was moved to the isolation room. In two places the animals suffered from dermatomycosis. The phenomenon of "sunflower" ear, i.e., twisted cartilage and skin on the ears, was very common. This phenomenon occurred regardless of the well-being or keeping of the animals. They were presented in the picture no 20. However, most often, because on 16/20 farms, the animals' ears and tails biting (picture no 19). The most common sightings the team observed are shown in photo 19. Only in 4/20 farms not a single individual with bitten ears or tails was observed. During the rounds after the pen were observed bitten ears and tails (presented on picture 19) were observed among animals in all housing systems studied. This happened despite the use of enrichments in the pens.



Picture 19. Sunflower ears (Author: Bernadetta Gwoździk).

Picture 20. Damage to the ears and tails (Author: Bernadetta Gwoździk).

Among the groups of animals, those with a hernia were also noted. Only when the hernia became leaky or large enough to prevent movement, the pigs were moved to isolation (presented on picture 21).



Picture 21. Pig with hernia (Author: Bernadetta Gwoździk).

5.4.5 Pen resource measurements

Among the surveyed farms, a large diversity was observed in terms of the types of feeders and drinkers used. The animals in the free-range farm and in the smallest of them were fed into the troughs. Water was given in the same way (presented in picture 22). It was observed that the greater the number of kept animals, the more automated the feeding and watering system was. Nipple or cup-shaped drinkers, presented in photo no 23. Water was observed to be clean on all the farms, but in one of piggery, drinker was completely soiled and not used by the animals. Despite this, they had other places to drink water at their disposal and willingly

used them. The farther the drinker was in the pen, the lower the pressure was. Most often fattening pigs used drinking bowls with the highest water pressure.

Picture 22. Watering animals from the hand (Author: Bernadetta Gwoździk).

Picture 23. Most often used drinkers (Author: Bernadetta Gwoździk).

In medium and large farms, the feed was fed automatically (presented in picture no. 24) to the troughs with separation on the shoulder girdle, with separation on the head and to round feeding bowls (picture 24). The last solution allows the largest number of animals to take food at the same time. The feeders mentioned above are presented in the pictures no 25. The feeder was already part of the pen, which was dirty. This was due to the dry feed being mixed with water.

Picture 24. Automatic feeding system (Author: Bernadetta Gwoździk).

Picture 25. Different types of feeders (Author: Bernadetta Gwoździk).

6 Discussion

With the growing popularization of environmental and pro-ethical aspects, changes in consumer attitudes and expectations are becoming visible. They mean that the quality of meat, identified with the broadly understood welfare and maintenance system of animals, including fatteners, is gaining in importance. This translates not only into the search (by buyers) for information on the specificity of rearing and slaughter, but also into the behavior of breeders and producers - who strive to optimize the quality of meat and the pork production process. One of the activities in this area is the implementation of a specific livestock production technology. In this context, more and more attention is paid to compare extensive and intensive solutions. This is facilitated, among others, by research confirming the increase in technological parameters of meat from animals from extensive system housing. Market requirements also favor the need to rationalize nutrition. On the other hand, the development of intensive (farm) technologies for the production of live pigs indicated significant difficulties, e.g., in the field of stress to which animals are subject and the consequences occurring as a result of its long-term impact [Peplinski 2013]. They can significantly determine the behavior of fatteners and determine the quality of meat obtained from them.

The aim of the conducted research was to collect data and observations from Polish extensive and intensive farms producing pigs in various husbandry systems (animals were kept in an open, closed and mixed system as well as in an intensive, semi-intensive and extensive system). For this purpose, data from 20 farms (both family and commercial) operating in our country were used.

The specificity of pig keeping systems translates into, among others, on the weight achieved by the fattening pigs. Research by Pepliński et.al. [2012] showed that the average weight of fatteners fed intensively is higher than in the group of animals fed extensively.

The specificity of pork production is also associated with the pig keeping system. The available analyzes have proven that currently in Poland there is considerable diversity in this respect. This is confirmed by the analysis performed by Kołacz [2017]. This author observed that, in country are both extensive systems (pasture maintenance, backyard breeding) and large farms operating in a closed cycle [Kołacz 2017]. Theoretically, in Poland, breeding in a closed cycle is more and more often abandoned and switched to a mode typical for an open or outlay cycle [Marquer et al. 2014]. Nevertheless, the closed system dominated in our own research (60%), while the open system was represented by 30% of the entities involved. In 10% of the cases, breeders used a mixed system. The semi-open system allows animals to use the paddocks. On the surveyed farms, made it easier to clean the pens while the animals were outside. In

addition, it allows you to increase the variety of the environment for exploration [Szulc, 2011]. The popularity of the closed system may be due to the fact that it enables the reduction of financial outlays and the achievement of satisfactory (profitable) breeding results. This is confirmed by e.g. research [Karpiesiuk 2020].

Moreover, on the farms included in the analysis, the conventional intensive system was dominant (16 out of 20 cases). The extensive system (3 entities) and the extensive ecological system (1 farm) were used less frequently. This specificity could result from the fact that the literature on the subject proves that intensive farms are the most optimal in terms of production and use of own production resources [Parafiniuk 2013]. Equally important, it turned out that in our own research, larger farms (and more precisely, entities with a larger number of animals) were better subsidized and showed higher investment involvement in renovation activities (and thus related to maintaining better living conditions). The legitimacy of this action is confirmed by research by Ziętara and Mirkowska [2022], from which it can be concluded that investing in livestock buildings for pigs is an activity necessary for the development of pigs on a larger, desirable scale - especially in production. Sass [2022] also emphasizes that while rearing piglets usually involves the need to take into account significant financial outlays for the construction of facilities that meet a number of requirements, fattening can be carried out within existing but properly adapted buildings. Such a solution provides the basis for conducting business on a scale that provides the farmer with a satisfactory remuneration for labour.

As in other cases, balanced and properly implemented nutrition plays an extremely important role in pig farming. In practice, it determines meeting the energy needs of animals and their demand for nutrients. However, it requires paying attention to the supply of nutritious and high-quality feed materials. Only such can have a beneficial effect on the nutritional well-being of pigs, which has a real impact on production results and generated income [Rekiel, Więcek 2018]. On farms covered by own research, as many as 17 entities produced fodder based on their own cereal cultivation. In 85% of cases, grain stocks were replenished (by purchase) only when there was a shortage of grain. This activity seems to be justified by the need to maintain an appropriate proportion between the cost of feed grains and the overall profitability of livestock production. As the literature proves, the costs of feeding fatteners account for as much as 70%-80% of all expenses incurred on keeping animals and obtaining raw materials from them [Pawłowski 2020]. In addition, it is assumed that the profitability of pig production is achieved while maintaining the relationship between the price of strip cereals and the price of live pigs at the level of 1:9 (calculated for rye). The relationship 1:7 can also be assumed as extreme values, below which production ceases to be profitable [Żekało 2013].

Therefore, it is often practiced running fattening pigs in parallel with the cultivation of cereals. It is one of the most frequently used forms of producers' independence from the industrial feed market. Many studies confirm that the cost of feed and its intake (estimated in relation to 1 kg of body weight gain) determine the overall efficiency/profitability of production [Sońta et al. 2020], although, as the observations in the surveyed farms showed, some farmers do not count the amount of feed intake and the conversion ratio.

Research conducted (under the Energyfeed program) confirms that cereals (population and hybrid varieties) are perfect for feeding fatteners. They are particularly recommended when achieving the desired fattening and slaughter characteristics (including, for example, daily gain, final body weight, fattening time, feed intake, slaughter efficiency or FCR feed conversion factor. Optimization in this respect is guaranteed by feeds containing 50-60% of rye of this type (i.e., containing acceptable - in fattening - values). In addition, the use of rye grain, it becomes possible to maintain the same or even higher (than in the case of feeding with rye-free fodder) production effects compared to the current prices of grain feed, own cultivation significantly reduces the expenditure incurred for feeding pigs [Wojtaszczyk 2022].

Studies cited by Figura [2017] indicate that, depending on the animal species, feed enriched with cereals can provide them with up to 85% of the necessary energy. At the same time, it is emphasized that breeders should be obliged to enrich feed with protein products (because cereals contain proteins of low biological value resulting, among others, from insufficient amounts of lysine, threonine or tryptophan). Cereal feeds should therefore contain properly selected super-concentrates, complementary mixtures, etc. Own research showed that all participants bought protein, oil, vitamin ingredients and a premix, i.e., they enriched the feed given to pigs, also in extensive fattening

Equally important, pig nutrition should be adjusted not only in terms of feed content, but also depending on the implemented system and breeding/production technology. It is related to the quality of the meat obtained [Knecht 2017]. Research by Lisiak et al. [2014] provide data indicating that in pigs fed in an extensive system, PSE (pale, soft, exudative) meat is diagnosed more often (than in the case of intensive feeding). In addition, the use of intensive feeding is conducive to reducing natural and thermal leakage as well as increasing the water absorption of fattening pig meat [Lisiak et al. 2014].

The quality of meat and the profitability of production depend not only on the factors mentioned above, but also on maintaining an appropriate level of biosecurity or biosecurity of farms. This applies to e.g., for the prevention of diseases - which is of particular importance in the case of e.g. the threat recognized in Poland resulting from the risk of ASF (African swine

fever) or other infectious diseases to which pigs are exposed. In our own research, half of the farms were in the pink zone - which proves the importance of this issue.

The report of the Supreme Audit Office [NIK 2018] shows that since 2017 the number of farms implementing appropriate protective solutions and procedures has been constantly growing. Entrepreneurs use both traditional and more innovative tools and devices. From the NIK report cited, it can be concluded that most often these are: disinfecting mats, roofed drive-through basins, disinfection gates, etc. In addition, domestic breeders are also paying more and more attention to: objects into zones (white/grey) or developing and enforcing rules/procedures managing aspects related to the movement of authorized persons (and those who do not have appropriate authorizations) around the farm and the livestock facilities belonging to them. Modern methods of disinfection, disinfestation and derealization (referred to as DDD) are also gaining in popularity [Pawłowski 2020]. Interviews and observations conducted as part of own research showed that the participants used various solutions in this regard, not always achieving the required level of security. However, deficits of this type did not negatively affect the health or behavior of the animals.

From the conducted analyzes it can also be concluded that in the areas covered by the research, various solutions and tools were used to reduce (in animals) stress, aggression and boredom. These were - depending on the system - toys placed in pens, chains, plastic bubbles, tires or licks. Despite this (and regardless of the system), fattening pigs occasionally displayed aggression (as a result of which, for example, they bit off their ears or tails - treated as a manifestation of cannibalism) and stereotyped behavior (stereotypes). These phenomena are particularly undesirable because they affect not only animal welfare but also the achieved production results. Petrynka et.al [2014] emphasize that, for example, cannibalism among fatteners not only reduces their daily growth but also increases the risk of infections as a result of injuries that occur in the herd. Other data available in the literature indicate that the symptoms of cannibalism are most often diagnosed in the situation of being kept on grates (preventing the satisfaction of natural needs related to burrowing). They are also favored by too high temperature, body weight of 50-75 kg or the period of the year (from October to December) [Stancelewska 2019]. It is worth emphasizing that stress (a manifestation of which is cannibalism and stereotypies) is not always the result of the breeder's negligence. It may also be the result of certain social conditions. Research conducted at the University of Warmia and Mazury in Olsztyn proved that stress occurs primarily in individuals dominant in the herd (i.e., fighting to gain or maintain an appropriate hierarchical position). However, it does not appear

in marginal individuals [Godzińska 2013]. Its reduction is not possible with external solutions (toys, etc.) as it is closely related to the social nature of pigs.

The analyzes carried out show that the quality of meat, profitability of production and the solutions used are inextricably linked to the broadly understood animal welfare. Its essence is respecting the 5 elementary "freedoms" of pigs. They are freedom from: hunger and thirst; physical and mental discomfort; pain, injury and disease; fear in a relationship with a person and the opportunity to expose normal behavior. For this reason, the production of fattening pigs must meet strict requirements resulting not only from applicable legal regulations or standards, but also from simple sensitivity to possible harm to animals.

7 Statements

1. Farms that cooperated in the project, mainly medium-sized family farms where members of the founders' families worked. The employees of the family did not know and could not estimate their hourly rates for work on the farm.
2. The maintenance system that prevailed in the group of farms was closed conventional intensive.
3. Farmers fed the animals to a greater extent with their products and agricultural products. Feed from the purchase came only when there was a lack of cereal components during the year. Protein, oil and mineral-vitamin products also came from shopping.
4. The native breeds showed a higher FCR.
5. Biosecurity, which farmers declared that they apply, had no reflection in reality.
6. Aggression and injuries resulted from lack of variety in the environment. The fewest abnormal behaviors were observed when animals were kept on deep bedding.
7. The obtained survey results will enable the development of model solutions for the organization of animal production in family farms and the development of recommendations for these farms in order to improve the level of production and economic efficiency while maintaining the highest standards and improving animal welfare.

8 Summary

To sum up, intensive and extensive fattening, despite many common goals and assumptions, are fundamentally different from each other. Conservative breeds are characterized by lower production efficiency, which translates into income from production, while maintaining these breeds allows you to take advantage of a larger pool of subsidies paid by the state. This is to encourage plants to keep native breeds, as well as partially compensate for the lost income compared to the income that could be obtained by keeping the breeds in intensive fattening. This, however, generates the need to increase financial outlays for the production. The results of the study confirmed this dependence, the intensive fattening farms were more economically aware, at the same time, they would not attach such importance to providing the animals with paddocks or the need for manipulation.

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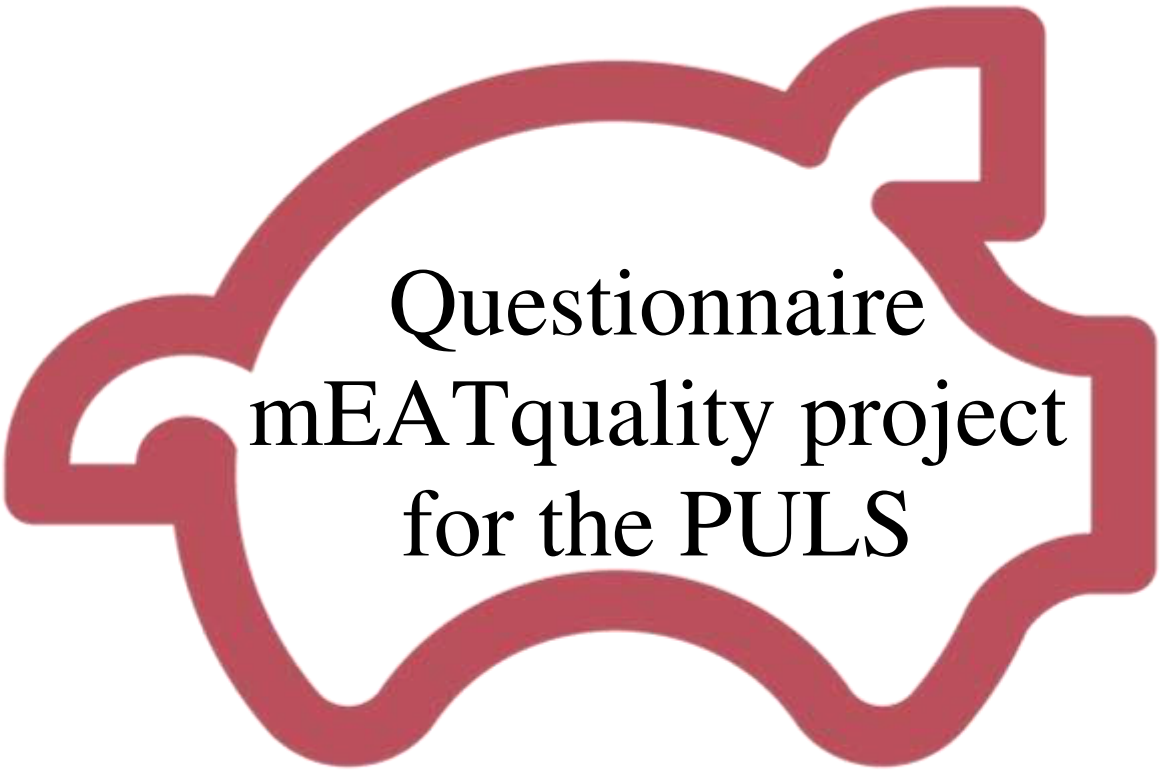
Attachments 1. Questionnaire mEATquality project for the PULS - management, economic and environmental protocol



Polish version of the surveys for the project protocol developed by:
PhD. Anita Zaworska-Zakrzewska, PhD. Małgorzata Kasprowicz-Potocka, MSc. Dagmara Łodyga and Eng. Bernadetta Gwoździk

1. Date of the interview:

2. Name and address of holding:

3. Production system:

4. Production cycle:

5. The breed of pigs you maintain:

6. Average pen size:

7. Area of the holding:

8. How many hectares of crops do you devote to the production of feed for pigs:

9. Do you keep breed books?

10. Live weight to which piglets are kept in the rearing room (kg)

11. Condition of animals at the beginning and at the end of the year 2021 / sale of animals and manure, productivity:

A	How many fattening pigs could you have had in January 2021? (n.)	
B	What average body weight could they have? (kg)	
C	How many fattening pigs could you have had in December 2021? (n.)	
D	What average body weight could they have? (kg)	
E	How many piglets went to the fattening house? (n)	
F	Purchase price (PLN/pcs.) *If it was not purchased, consider the reference market price for the same type of piglets*	
G	Do slaughterhouses pay for: live weight of carcass, warm weight of carcass, cold weight of carcass?	
	CUSTOM SCALE	
H	Average **live** weight at slaughter of pigs sold of a weight other than standard (kg/head)	
I	Average **warm carcase** weight of pigs sold of a weight other than standard (kg/head)	
J	Average **cold** carcase weight of pigs sold of a non-standard weight (kg/head)	
K	Number of pigs sold of a weight other than the standard (No.)	
L	Average fattening period of pigs in weight other than standard (days)	
M	Sale price of non-standard pigs (PLN/piece) *(how much does the slaughterhouse pay for fattening pigs?)*	
N	Mortality of pigs sold in a weight other than the standard, including culled pigs (%)	
O	Feed utilisation rate for pigs sold in weight other than standard (kg/kg)	
P	Average daily increase in pigs sold in a weight other than standard (g/day)	
R	Overall mortality in the fattening house (current) (%)	
S	Average daily weight gain (g/day)	
T	Current number of fattening pigs	
U	How many animals died during transport to the slaughterhouse? (proportion of animals destined for slaughterhouses and finally slaughtered)	
W	Subsidies for endangered/rare breeds (PLN/year)*(if applicable)*	
Y	Sale of manure (PLN/year)	

12. Nutrition: Compound feed

Specification	From weight	To the scale	Feeding period
Compound feed	From kg/pc.	Up to kg/pcs.	Days

13. Doesthe feed contain phytase and/or synthetic amino acids (if so, which ones)?

Quantity of feed purchased (tonnes of fresh weight/year)	
Distance from main feed supplier/seller (km)	

14. Farm workers

	Specification	**Total hours worked/week**	**% allocated to pig production**
A	Worker from the family …..		
B	Labour costs, including social security contributions (PLN/hour)		
C	Full-time employee …..		

15. (a) Farm management costs in 2021 (i.e. cost items for the whole farm)

	Specification:			
A	Wages + social security contributions paid to employees **PLN/year**			
B	Quality system/certification (e.g. organic, PDO, PGI)			
C	Farm insurance			
D	Taxes (not VAT)			
E	General and administrative costs (e.g. office supplies, bookkeeping)			
F	Water			/year
G	Straw (if applicable)			kg/year
H	Other bedding materials and enrichment elements			
I	Cleaning products, disinfectants, other consumable cleaning materials			
J	Petrol/Oil			litre/year
K	Gas (methane, natural gases, other types of gases)			/year
L	Current			kWh/year
M	Biomass for heating (e.g. wood peet)			kg/year
N	Disposal of fallen stock			kg/year
O	Manure disposal			t/year
P	Transportation (general)			
R	Management (general)			
S	Consultancy			

15. (b) Other costs (cost items relate to one fattening pig):

	Specification:	**zł/ pig**
A	**Quality certification system (if applicable)**	
B	**Transport from the nursery to the fattening house (if applicable)**	

C	**Transport to the slaughterhouse**	
D	**Other: health certificates**	

If the farmer does not know the costs of the above items per pig, enter the cost for the entire calendar year (2021): _____

16. Economic conditions

Percentage of revenue from the sale of fattening pigs in relation to the income of the whole holding: %	**%**

17. Pens in the pigsty

Coops	**Fattening house**
Total number of grid slots	
Total number of seats on partially grated floor	
Total number of places on the concrete floor	

18. Pen size according to age groups:

Age group:		
Wed. multiplicity of the pen	Min. pen size	Max. pen size

19. Allocation of space in pens depending on age groups

Age group:		
Wed. total area m^2	Min. total area m^2	Max. total area m^2
Wed. Area m^2/animal	Min. area m^2/animal	Max. area m^2/animal

18. Regrouping of animals according to age groups:

**Mixing animals – how many times one animal is mixed with others – in order to get acquainted*
**Animal regrouping - number of changes within a group of pigs (including mating with other groups and divisions) - does not apply to individual animals*

Age group:		
Average number of animal mixes	Min.	Max.
Average number of regroupings	Min.	Max.

19. Enriching roughage, materials, straw – depending on age groups:

ENRICHING ROUGHAGE

Enriching roughage – type:	
Age group:	
Wed. how much kg/day/animal	How many days per week do pets have access to this?
Enriching roughage – type:	

EXPLORATORY MATERIALS:

What enrichment material (e.g. chains):	
Age group**:**	
Wed. how much kg / day / animal	How many days a week do pets have access to this?
What enrichment material (e.g. chains):	
Age group**:**	
Wed. how much kg / day / animal	How many days a week do pets have access to this?

STRAW:

Age group:	
Wed. how many kg/day/animal	How many days a week do animals have access to it?
Age group:	
Wed. how many kg/day/animal	How many days a week do animals have access to it?

20.Watering

Age group:		
Type of drinkers	Type of drinkers: Manual: avg. number of animals per drinker Mechanical: Avg	
	Mechanical: Avg. Number of animals per drinker	
Freeze protection	Yes	
	No	
Water availability		
Distance	The ratio of pigs with attachments ad lib. (24/7)	

21. Feeders

Age group:		
Feeding system	Electronic	
	Individual	
	With separators	
	Round feeder	
	Feed table	
	Other:	
Feeder availability	Wed. number of animals per feeder	
Wet or dry feeding?	Dry	
	Wet	
Feed availability	Feed intake of animals with *ad libitum*(24/7)	
	If *ad libitum* access is not available, enter avg. number of hours in a day	
	How many times a day are pigs fed? (if they don't have ad lib access)	

22. Access to cooling systems

What kind of cooling? (mats, showers):	
Age group:	
The ratio of animals that can cool at the same time?	

23. Environmental information

Manure management system fraction*	**Amount of manure (%)management systems**
Liquids/slurry and storage in a pit below animal enclosures (how many months?) _____	
Shallow litter: how often is it removed? _____	
Deep litter: how often is it removed? _____	

24. Renewable energy

Photovoltaics		kWh/year
Biogas		kWh/year
Electrical energy		kWh/year
Wind kWh/year		kWh/year
Other renewable energy		kWh/year
Description of any other renewable energies		

25. Waste

Undifferentiated (unsorted) waste		kg/year

26. Fertilizers

Type and quantity of mineral and/or organic fertilisers used exclusively for feed used in the feeding of pigs:	kg/year

27. Questions with a scale (1- very easy, 5-very difficult) or marking the answer:

Very easy – 1/ Very difficult- 5
How easy would it be for your feed supplier to find a replacement for the feed you currently buy from them?
How easy would it be for your meat processor to find another farm that would provide him with animals?
To what extent can you influence the prices of supplies and services (feed, labour, energy)?
To what extent can you influence the selling price of pigs?
To what extent can you influence the amount of pigs you can produce and deliver to processors?
To what extent can you influence the payment method and discounts?
To what extent can you influence the quality of the meat produced?
To what extent will the transition to more extensive pig production result in greater market access and the ability to bargain for better prices for your pigs?
To what extent will the transition to more extensive pig production result in greater profitability of the farm?
In your opinion, how difficult is access to free farm advisory services?
How easy would it be for you to get a loan to modernize your farm?
To a large extent -1/ To a small extent- 5
To what extent are you trained or prepared to expand the pig housing and management systems on your farm?
To what extent does your financial situation allow for large investments?
Big/ a lot- 1/ Small/ little- 5
How much value has you invested in your farm compared to others?
How many options are available for you to use for your farm, to carry out extensification or to continue it? (E.g. do you have access to open space and land or are there any urban restrictions, residential areas, etc.)
Fast and willing – 1/ Reluctant - 5
How quickly would you apply newly developed products, technologies or practices to your farm?

Yes/ No
Have you participated in training related to your agricultural activity (pig production) in the last 2 years?
Have you received any training related to extensive pig production in the last 2 years?
If you have employees (including family members), do they have the opportunity to receive training for further development?
Are you a member of a producers' association?
Are you a member of an organisation (producer group) buying feed, piglets or using machinery?
From/to
How old is your farm equipment on average?*only used for pig production
How old are your pig livestock buildings on average? *only used for pig production

28. Was it necessary to move the animals to isolated pens, what was the reason? (e.g. lameness

29. Indicate what measures are in place on the holding to prevent the spread of African swine fever

		Yes/No
A	Fence the area	
B	Disinfectant mats at the entrance to the farm	
C	Disinfectant mats at the entrance to the pigsty	
D	Do other animal species have access to pig farms?	
E	Is a protective peel used before entering the pigsty	
F	Is there other footwear before entering the pigsty	
G	Is there a list of entrances/exits to the farm	
H	Is there a biosecurity system in place	
I	Is there mandatory quarantine for newly purchased animals	
J	Are pests (insects, rodents) controlled on the farm	
K	Are there nets in the mocks/windows on the farm?	
L	Other: DISINFECTION OF MACHINES AFTER RETURNING FROM THE FIELD	
M	Zone	

30. Is there a rainwater collection system on the farm?

31. Is there a plan to use water (rainwater) for consumption?

32. Is there a plan to use water (rainwater) for cleaning?

33. Is there a water use plan on the farm?

34. Is there a pressure washing system on the farm?

35. Do you check the condition of the pipes that transport water to the animals every day?

36. Is there natural ventilation in the pigsty?

47. Is the thermal comfort of animals based on the use of deep litter?

48. Is there an automatic/electric temperature and ventilation controller in the pigsty?

49. How common are problems with pets biting their tails?

40. Were the petioles of the animals removed (the last throw of the animals)?

41. Were animals (both boars and gilts) castrated (last wave of animals)?

42. Were there other invasive procedures (last wave of animals)?

43. Is there a recording of the on-farm electricity/renewable energy consumption?

44. Is there system of additional lighting installed in the pigsty besides the natural one?

Attachments 2. mEATquality (mq)- REGISTRATION PROTOCOL for ON-FARM ANIMAL WELFARE ASSESSMENT

Fill in the first half of the schema before approaching the pens/flocks. Fill in second half af the schema after step 2 - the avoidance test								NA	Not Applicable		
Fill in the first half of the schema before approaching the pens/flocks. Fill in second half af the schema after step 2 - the avoidance test								NR	Not recorded		
Country (PL, ES, IT, DK)	**Farm ID**	**Farm type**	**Farm type other**	**Date** (dd-mm-yyyy)	**Observer** (Initials)	**Assessed year** yyyy	**Comments/Notes**				
		EO = Extensive (pasture or alike), Organic EC= Extensive (pasture or alike), Conventional IIC =Intensive, Indoor, Conventional IORC = Intensive, Outdoor Run, Conventional IORO = Intensive, Outdoor Run, Organic Other = Write what in variable 'Farm type other'									
			Hectare to m2 Converter								
			Hectare	m2							
		Fill in m2		0							
Pen / Flock	**Space allowance - Indoor, m2**	**Space allowance - outdoor run or other outdoor, m2**	**Breed**	**Number of pigs**	**Avg age of pigs, weeks**	**Min age of pigs, weeks**	**Max age of pigs, weeks**	**Avg weight of pigs, kg**	**Min weight of pigs, kg**	**Max weight of pigs, kg**	
1											
2											
3											
4											
If needed (for the clinical assessment only):		Space allowance Outdoor (other), Breed, Number of pigs, Avg, min and max age of pigs, Avg, min and max weight of pigs: Ask farmer									
Pen / Flock	**Space allowance - Indoor, m2**	**Space allowance - outdoor run or other outdoor, m2**	**Breed**	**Number of pigs**	**Avg age of pigs, weeks**	**Min age of pigs, weeks**	**Max age of pigs, weeks**	**Avg weight of pigs, kg**	**Min weight of pigs, kg**	**Max weight of pigs, kg**	
5											
6											
7											
8											

mEAT quality

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STEP 2 - AVOIDANCE TEST (Updated 06.06.2022, Tine Rousing)

• Number of pigs showing panic/avoidance defined as 'fleeing' away from the assessor including huddling up in the corner. This does not include

Pen / Flock	AVOIDANCE TEST				*Testing Indoor(I) or Outdoor(O)*
	Observer (initials)	**Time test start** (hh:mm)	**Number avoiding**	**Number of pigs observed**	
1					
2					
3					
4					

PENS /PADDOCKS OUTDOOR: Approach the pen/paddock and immediately ENTER it (only one person!) - and stand still at the 'gate' for 30 seconds. Hereafter walk slowly around the pen for 30 seconds without initiating any

FLOCKS OUTDOR: Approach the flock (only one person) - and stand still CLOSE to it for 30 seconds. Hereafter walk slowly around the flock for 30 seconds

Step 3 - HABITUATION TIME / PEN DIRTYNESS, BEDDING and ENRICHMENT MATERIAL

Pen / Flock	**Observer** (initials)	**Time test start** (hh.mm)	**Bedding - Cover**	**Bedding - thickness**	**Dirtiness**
1					
2					
3					
4					

While standing OUTSIDE the pen / AWAY from the flock in 5 minutes and hereby habituate the animals to

• Bedding - cower: 1: Whole area, 2: Whole Lying area,

• Bedding - thickness: 1: Thick/deep litter, 2: Medium,

• Pen dirtiness: 1: Less than 10%, 2; not 1 and 3, 3:

ENRICHMENT • For each of the listed enrichment materials, the number (N) or amount (in kg) of accessible enrichment materials at the moment for observationare is measured. Ask farmer if needed.

Pen / Flock	Wood, N pieces	Roughage		Straw (other than bedding), kg	Plastic elements, N pieces	Chains, N pieces	Other		
		Type	Amount, kg				Type (eg wood chips, compost..)	Amount (kg)	Amount (N pieces)
1									
2									
3									
4									

STEP 4: BEHAVIOUR SCAN (Updated 06.06.2022, Tine Rousing)

After the habituation time of 5 minutes, the behaviours of all pigs are studied as a 'here-and-now observation' = scan.

• Number of pigs doing what is listed below is counted - considering the 'variables' (wall, floor...) one by one. Note that pigs can do more than one thing at a time (eg.hudling and manipulating other pig) registration. It will take approximately 3

Pen / Flock	**Observer** (initials)	**Time test start** (hh:mm)	Number of standing pigs (not including eating and drinking pigs)	MANIPULATION / EATING / ROOTING							Number of pigs observed	Observing Indoor(I) or Outdoor(O)
				Wall	Floor	Pen fix type (eg. iron bars)	Pen fix	Pig**	Ear***	Tail***		
1												
2												
3												
4												

Pen / Flock	Wood	Roughage type*	Roughage	Straw	Plastic elements	Chains	Other type	Other*
1								
2								
3								
4								

Pen / Flock	HUDLING, PANTING and SHIVERING				STEREOTYPIES
	Hudling	Hudles	Panting	Shivering	
1					
2					
3					
4					

MANIPULATION/ROOTING: The pigs are touching/rubbing with their snout and/or biting the respective substrate. * Roughage type and Other: short description.

** Pig: Other body part than ear and tail....include belly nosing and biting. Does not include gentle manipulation. *** Ear and tail: Includes only if the the respective body partis in-the-mouth.

HUDLING and HUDLES: Hudling: Number of pigs lying with more than ½ the body in contact with another pig/pigs. Hudles: Number of 'piles' of pigs.

PANTING: Rapid breathing rapidly in short gasps. SHIVERING: Slow and irregular vibration of any body part or the body as a whole.

STETREOTYPIES: Relatively invariable repeated sequence of movements with mouth that has no obvious function. At least 3 times in a row.... maybe as a sequence of different behaviour elements (not

STEP 5: BEHAVIOUR CONTINIOUS COUNT (Updated June 1st 2022, Tine Rousing)

After the behaviour scan, the behaviour of all pigs are studied for 10 minutes.

• Number of occations/events of the below listed behaviopur are counted (the individual pig can do several of these).

Pen / Flock	**Observer** (initials)	**Time test start** (hh:mm)	Number of standing pigs	**PLAY**	**AGGRESSION**	**MOUNTING**	**Number of pigs observed**	**Observing Indoor(I) or Outdoor(O)**
1								
2								
3								
4								

STEP 6: CLINICAL EXAMINATION (Updated 06.06.2022, Tine Rousing)

After all behaviour measures, the clinical can be carried out. All pigs (both 'sides') in the respective pen/paddock/flock are observed - not including palpation - and the below listed is counted.

Observer (initials)	**Time test start** (hh:mm)

		BCS			**BITTEN TAILS**		**TAIL LENGTH**			**BODY WOUNDS**				
Pen / Flock	**Number of pigs clinical scored**	**Lean**	**Fat**	**RUNTS**	**Mild**	**Severe**	**Short**	**Stump**	**AR WOUND**	**Mild**	**Moderate**	**Severe**	**COUGHING**	**SNEEZING**
1														
2														
3														
4														

	LAMENESS		**ECTOPARASITES**	**SUNBURN**	**HERNIA**		**BURSAE**			**DIRTINESS**	
Pen / Flock	**Obviously**	**Severely**			**Moderate**	**Severe**	**Small**	**Large**	**Extremely**	**Moderate**	**Severe**
1											
2											
3											
4											

STEP 7: FEEDERS and DRINKERS Updated 06.06.2022, Tine Rousing)

After all behaviour and clinical are caried out, these remaing pen measurements are assesse.

• In the 4 pens all fedders and in total up to 10 drinkers are included.

Observer (initials)	**Time test start** (hh:mm)

FEEDERS

Pen / Flock	**Number of feeders**								
	Individual electronic (with chip)	**Indiv feeding stall**	**Through w head separation**	**Through w shoulder separation**	**Through without separation**	**Round**	**Floor ('1' for releevnat, '0' for not relevant)**	**Other**	
								Type (text)	(Number)
1									
2									
3									
4									

Pen / Flock	**TOTAL length of feeders (cm)***								
			Through w head separation	**Through w shoulder separation**	**Through without separation**	**Round (perimeter), calculation needed 2*3,1415*radius**		**Other**	
								Type (text)	(Lenght)
1									
2									
3									
4									

	TOTAL number of feeding spaces								
Pen / Flock			**Through w head separation**	**Through w shoulder separation**				**Other**	
								Type (text)	(N feeding spaces)
1									
2									
3									
4									

*

Number of feeders: For each of the pens the total number of each type`of feeder is counted

Lenght of feeders: For each through, round feder and other feder in the pens the total

Numer of feed spaces: For each feed separated feders the number of feeding spaces are

Observer (initials)	**Time test start** (hh:mm)

DRINKERS

Pen / Flock	**Number of functioning drinkers**				
	Bowl	Nipple	Through	Aqaua level	Natural water source
1					
2					
3					
4					
Pen / Flock	**Number of non-functioning drinkers**				
	Bowl	Nipple	Through	Aqaua level	Natural water source
1					
2					
3					
4					
Pen / Flock	**Number of dirty drinkers**				
	Bowl	Nipple	Through	Aqaua level	Natural water source
1					
2					
3					
4					
Pen / Flock	**Total lenght of drinkers (m)**				
			Through	Aqaua level	Natural water source
1					
2					
3					
4					

Water flow l/min

Drinker	Pen / Flock no.	Water flow (Liter/min)	**Drinker**	Pen	Water flow (Liter/min)
1			6		
2			7		
3			8		
4			9		
5			10		

Number of functioning and non-functioning drinkers: For each pen the total number of respectibe type is counted.
Number of dirty drinkers: For ech pen the total number
Water flow: For up to 10 drinkers across the pens the water flow is calculated based on timing the fillin of a countaining of a known voulume. Only relevant for

Formularz F4

Oświadczenie autora pracy dyplomowej o jej oryginalności, samodzielności jej przygotowania i o nienaruszeniu praw autorskich

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imię i nazwisko studenta

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nr albumu

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- nie przepisałem pracy lub jej części z innych opracowań i prac związanych tematycznie z moją pracą,
- korzystałem jedynie z niezbędnych konsultacji,
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data i czytelny podpis autora

[1] Uwzględniając merytoryczny wkład promotora.

Formularz F5

Oświadczenie autora o zgodności
elektronicznej wersji pracy z jej formą wydrukowaną

……
imię i nazwisko studenta

……
nr albumu

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……

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