Food and Agriculture Organization of the United Nations

ANTIMICROBIAL USE PRACTICES IN THE LIVESTOCK SECTOR IN BOSNIA AND HERZEGOVINA

SURVEY REPORT

UNDERSTANDING ANTIMICROBIAL USE IN FOOD AND AGRICULTURE

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ANTIMICROBIAL USE PRACTICES IN THE LIVESTOCK SECTOR IN BOSNIA AND HERZEGOVINA

Survey report

Food and Agriculture Organization of the United Nations

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ACKNOWLEDGEMENTS

Anne Deckert, Daniel Beltran-Alcrudo, and Eran Raizman developed the surveys and associated materials (e.g. field instructions, consent forms, etc.) to assess the use of antimicrobials in the livestock sector. Dora Kovacs and Daniel Beltran-Alcrudo created the templates and guide for survey analysis and reporting, with technical input from Anne Deckert and Eran Raizman.

The Association to Combat Land Degradation and Environment Protection "Mother Nature" coordinated the field implementation, which included translating the surveys, compiling information on antimicrobial products, and conducting pilot surveys. Daniel Beltran-Alcrudo oversaw this work. The "Strategic Development Agency" (SDA) managed the online implementation of the surveys through the KoboCollect platform.

Marijana Kapovic Solomun, Aleksandra Kutić and Duško Solomun (from "Mother Nature") conducted the survey analysis and report writing, with technical input from Dora Kovacs.

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ABSTRACT

To support countries in tackling antimicrobial resistance (AMR) and promote the prudent use of antimicrobials in the livestock sector, the Food and Agriculture Organization (FAO) developed and carried out surveys in a series of countries on antimicrobial use (AMU) in the livestock sector by priority livestock production systems, field veterinarians, veterinary pharmacies, and feed mills. The activity "Baseline study conducted in Bosnia and Herzegovina on antimicrobial use (AMU) in priority livestock species, field veterinarians and veterinary pharmacies to inform policies in addressing antimicrobial resistance (AMR)" was conducted as part of FAO's Regional Initiative 2 (RI-2), Output 2.2.1, Promoting the One Health approach, which also targeted other countries or territories in the Europe and Central Asia region.

In Bosnia and Herzegovina (BiH), surveys targeted 538 farms of priority livestock production systems (cattle, small ruminants, chickens, pigs, bees, and backyard), 100 veterinarians, 100 veterinary pharmacies and 8 feed mills. Participants were interviewed face-to-face between 12 July and 30 August 2022, and their responses were collected on electronic devices (tablets) through the KoboCollect platform. After completion of the survey, participants were provided with an information leaflet on the use of antibiotics in livestock, and misconceptions were explained to them.

This report is the first of its kind to provide a comprehensive overview of AMU in the livestock sector in Bosnia and Herzegovina, including the sources of antibiotics, the main use patterns (e.g. common routes of administration; aim of use, such as treatment, prevention or growth promotion; use in different age groups), the main indications of antimicrobial treatment, drugs used in different animal species, the handling of antibiotics, and awareness of AMR. The analysis found important gaps in the knowledge and practices of participants. It highlighted the low education level of farmers, the scarcity of thorough record keeping and lack of some biosecurity measures on livestock farms, the inappropriate disposal of expired antibiotics by farmers, and the frequent use of highest priority critically important antimicrobials. Targeting these gaps in the future could lead to a reduced need for antimicrobials and would support the prudent use of them, thus reducing the risk of AMR development.

INTRODUCTION

Antimicrobial resistance (AMR) is a major threat to human, animal, and plant health. A main driver of AMR development is the overuse and misuse of antimicrobials; therefore, it is crucial to gain knowledge on antimicrobial use (AMU) practices and to support the prudent application of these drugs in all fields. The livestock sector has a special role in this process, since AMR developed in food-producing animals can enter the food chain and the environment.

The aim of this survey was to collect information on AMU in the livestock sector in Bosnia and Herzegovina (BiH) from farmers of priority livestock production systems, field veterinarians, veterinary pharmacies, and feed mills. Analysing the collected data allowed for the identification of knowledge gaps and inappropriate practices. Based on these, intervention measures can be implemented to promote the prudent use of antimicrobials, thus reducing the development of AMR, while improving animal health and productivity.

A description of the materials and methods, together with the key findings and recommendations are provided in the following pages. A detailed and systematic description of all the survey questions and answers can be found in the following chapters and annexes.

MATERIALS AND METHODS

The activity "Baseline study conducted in Bosnia and Herzegovina on antimicrobial use (AMU) in priority livestock species, field veterinarians and veterinary pharmacies to inform policies in addressing antimicrobial resistance (AMR)" was part of FAO's Regional Initiative 2 (RI-2), Output 2.2.1, Promoting the One Health approach, which aims to better understand AMR risk factors and threats in the Europe and Central Asia region. The survey and survey instructions were developed by FAO (Annex 1). The survey implementation was conducted by the Association to Combat Land Degradation and Environment Protection "Mother Nature" through a letter of agreement signed with the Food and Agriculture Organization of the United Nations (FAO).

Farmers (of priority livestock species), field veterinarians, feed mills and veterinary pharmacy personnel were interviewed (face-to-face) between 12 July 2022 and 30 August 2022. The several hundred participants were located in selected entities (Federation of BiH and Republic of Srpska) of BiH. The number of surveys was distributed among the entities as evenly as possible. The total number of surveys performed can be seen in Table 1.

Table 1. Total number of surveys performed in Bosnia and Herzegovina by region and stakeholder

Participants		Number of surveys - planned		Total number of surveys - actual	Number of surveys - actual	
		Republic of Srpska	Federation of BiH		Republic of Srpska	Federation of BiH
Farmers	Dairy farmers	50	50	102	44	58
	Beef farmers	50	50	108	49	59
	Small ruminant farmers	10	10	30	11	19
	Chicken farmers	10	10	21	7	14
	Pig farmers	20	0	23	23	0
	Bee farmers	20	20	46	28	18
	Backyard farmers	100	100	208	115	93
Veterinary pharmacy personnel		50	50	100	48	52
Veterinarians		50	50	100	46	54
Feed mills		4	4	8	4	4

Source: Authors' own elaboration.

Survey data collection was carried out through electronic devices (tablets) and responses were recorded in the KoboCollect platform. The five enumerators who conducted the surveys were usually accompanied by the supervisor of this activity. Technical and administrative staff were also involved in communication and coordination of the visits. The questionnaires were provided by FAO and were translated into Serbian, Bosnian or Croatian for implementation. Before the surveys, pre-testing of the questionnaires was carried out and enumerators were trained on survey implementation. All participants had to sign an informed consent before the administration of the survey, and their personal information was treated confidentially. Details on the survey process are available in Annex 1 (Survey instructions). Where the most commonly used antimicrobials had to be reported, a coded list of antimicrobials was provided to participants, and they responded

with the numbers corresponding to the veterinary medicinal product used. The list of antimicrobials can be found in Annex 2.

For farmers, the survey was divided into a first, general part (*Farmer section*), that had to be completed by all participants, followed by a species-specific part that was chosen and completed based on the animal species housed on their farms.

Upon completion of the survey, participants were provided with an information leaflet on the use of antibiotics in livestock and the issue of AMR. All surveys were checked by the interview supervisor to ensure they were complete and correct. The responses were then analysed using Microsoft® Excel and Access.

KEY FINDINGS AND RECOMMENDATIONS

In BiH, farmers were mainly over the age of 40, while most veterinarians and veterinary pharmacy personnel were between 25 and 40 years of age. All fields had a significantly higher ratio of males to females.

Most farmers of priority livestock species did not have previous education or training in animal health, animal husbandry, or other areas related to farming. Record keeping was generally a rare practice among farmers in BiH. Most farmers had no records on animal health related data (e.g. treatments, vaccinations, veterinary visits). The majority of them stated during the survey that they rely on veterinarians for keeping records. This was in accordance with the replies collected from veterinarians, as almost all of them had records of the antibiotics they sold or prescribed, and the farms where they work. Similarly, veterinary pharmacies were keeping thorough records of antibiotic sales.

Hygiene and biosecurity measures performed on the surveyed farms varied depending on the animals housed, except for using wheel or vehicle disinfection and providing overalls and boots for visitors, which were rarely practiced on most farms. Furthermore, separation of new and sick animals from others was not practiced regularly by many farmers. There were also some areas for improvement in the milk hygiene practices of dairy farms. Vaccination was rarely reported, regardless of the animal species kept on the farm.

Overall, less than half of the surveyed farmers reported using antimicrobials in their animals, however, the ratio of antibiotic users was different between animal species and farm types: being more common on commercial pig, chicken and cattle farms, and less common on small ruminant, bee, and backyard farms. Farmers with education or training in animal health or other related areas were more likely to use antibiotics than farmers without education. However, using antibiotics was generally not a first-choice measure in case of disease on the surveyed farms.

Farmers mainly purchased antimicrobials from veterinary pharmacies and veterinarians, and 61 percent of them always used a prescription for buying these drugs. Around 16 percent reported buying antibiotics with a prescription often, but the rest only occasionally or never had a prescription. This was more or less in accordance with the responses of pharmacists: 76 percent of them reported always requiring a prescription for selling antibiotics, and the rest (24 percent) often required a prescription. When selling antibiotics to farmers, all veterinarians, and 98 percent of veterinary pharmacy personnel reported informing the farmers about the withdrawal period.

The decision to use antimicrobials, and the dose and duration of treatment originated from veterinarians on most farms. In some cases, farm owners also decided to use antimicrobials. Interestingly, almost all farmers (92 percent) used antibiotics as advised in terms of dose, but only 82 percent followed the advice of the veterinarian regarding the length of treatment. The remaining farmers were likely to use antibiotics for longer periods than prescribed. When the antibiotic treatment did not yield the expected results, most farmers called the veterinarians for advice, except for 35 percent of the surveyed beef farmers, who either started using another antibiotic, or repeated the treatment with the same substance.

Farmers mainly used antimicrobials for the treatment of diseases, while preventive use was not common. In contrast, 26 percent of veterinarians reported also administering these drugs for preventing diseases. Individual treatment was preferred by veterinarians over group treatment. The use of antibiotics for enhancing growth or production of animals was reported by a small

number of dairy cattle and pig farmers only. Interestingly, 21 percent of veterinarians thought that antibiotics are important for improving animal growth or production, but none of them reported using them for this purpose.

Farmers' knowledge about AMU was generally good, except for many not being aware of the human health risk of using antibiotics in animals, not knowing the difference between antibiotic residues and AMR, and not knowing that the use of vaccines can reduce the need for antibiotics. Interestingly, even though most farmers knew that antibiotics cannot be freely discarded without having an effect on the environment, many of them (34 percent) reported throwing expired antibiotics into the garbage. Farmers with less experience in livestock, farmers without previous education or training, younger and female farmers scored worse in the questionnaire assessing AMU knowledge. As for awareness of AMR, only 63 percent of farmers reported having heard about this phenomenon, while all veterinarians and veterinary pharmacists had AMR included in their education. Unfortunately, only 39 percent of farmers replied that they would be interested in learning more about antibiotics.

Sending samples to diagnostic laboratory was not a priority measure of the surveyed farmers in case of disease, and almost none of them reported sending samples for antimicrobial susceptibility testing if the antimicrobial treatment did not yield the expected results. In contrast , most veterinarians reported that they would take samples for laboratory analysis in single cases and disease outbreaks. Veterinarians also reported having good access to laboratories, and AMR testing being available at the laboratories that they work with.

Antibiotics that were commonly used, advised or sold in BiH by the different stakeholders are listed below, including their ranking according to the World Health Organization (WHO)[1]. The most frequently reported substances are written in bold.

- Highest priority critically important antimicrobials: colistin, **enrofloxacin**, marbofloxacin
- Critically important antimicrobials: **gentamicin**, neomycin, **streptomycin**
- Highly important antimicrobials: **amoxicillin,** doxycycline, florfenicol, lincomycin, **oxytetracycline**, **penicillin**, **sulphonamides alone or with dihydrofolate reductase inhibitors**
- Important antimicrobials: spectinomycin, tiamulin

Among the indications, mastitis, intestinal diseases, breathing problems and lameness in various animal species were most commonly treated with antimicrobials. The opinion of different stakeholders on the efficacy of antibiotics was similar: 80 percent of farmers, 78 percent of pharmacists and 72 percent of veterinarians thought that antibiotics are as effective as they were previously, while the rest of them perceived decreased efficacy of these medications. The lockdown due to COVID-19 did not have a significant impact on animal health and the accessibility of veterinary drugs and services in BiH.

Based on the main findings summarized above, the following recommendations can be given to BiH to support the prudent use of antimicrobials and decrease the need for use of these drugs:

- train farmers on good animal health and animal husbandry practices, stressing issues related to the prudent use of antimicrobials and AMR, including the importance of the

[1]WHO's List of Medically Important Antimicrobials: a risk management tool for mitigating antimicrobial resistance due to non-human use. Geneva: World Health Organization; 2024.

prescribed treatment duration, the right disposal of antibiotics, antibiotic residues, and the human health risk of using antibiotics in animals;
- support the improvement of hygiene and biosecurity measures on livestock farms;
- support vaccination;
- promote record keeping of animal health and drug use related data among farmers;
- reduce or eliminate the use of antibiotics for enhancing animal growth or production;
- reduce the use of Highest Priority Critically Important Antimicrobials as first-choice drugs in livestock, if less valuable substances are also available and can be effective;
- promote the importance of laboratory testing among farmers; and
- support the use of digital prescriptions.

FARMER SURVEYS

FARMER SECTION

General data of surveys

Total number of surveys (farmer section): 275

Total number of farmer surveys (species section): 538

(Each farmer completed surveys for an average of 2 different species)

Note: The survey was conducted during the period of intense seasonal labour on the farms, so interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked, but were not surveyed, were not recorded. There were also cases when the survey was started and after some time, given the large number of questions, farmers quit and did not answer all the survey questions.

Date of surveys

- First survey: 12 July 2022
- Last survey: 26 August 2022

Distribution of surveys

- Entity
  - Republic of Srpska: total: 277 (51.5 percent), farmer section: 152 (55.3 percent)
  - Federation of BiH: total: 261 (48.5 percent), farmer section: 123 (44.7 percent)
- Municipalities: 28 municipalities
  - 14 from Republic of Srpska
  - 14 from Federation of BiH

Information on farms and farmers involved in the survey

Type of farms included

- Semi-commercial .....164 (59.6 percent)
- Backyard.....106 (38.6 percent)
- Large commercial..... 4 (1.4 percent)
- Government..... 1 (0.4 percent)

Role and education of farmers

Among the surveyed farmers:

- 98.2 percent were the owner of the farm;
- 1.5 percent were the manager of the farm;
- 6.6 percent were an employee; and
- 0.4 percent were veterinarians.

Note: More than one answer could be provided.

Generally, only a low number of the surveyed farmers had previous education (1.8 percent) or training (23.3 percent) on animal health. There was a similar ratio in case of animal husbandry: 4.4 percent had education and 34.6 percent had training, while for pharmacology, 0.7 percent of respondents had education and 4.4 percent had training. Detailed responses to this part of the survey can be found in Annex 3.

Figure 1. Entities of Bosnia and Herzegovina involved in the surveys

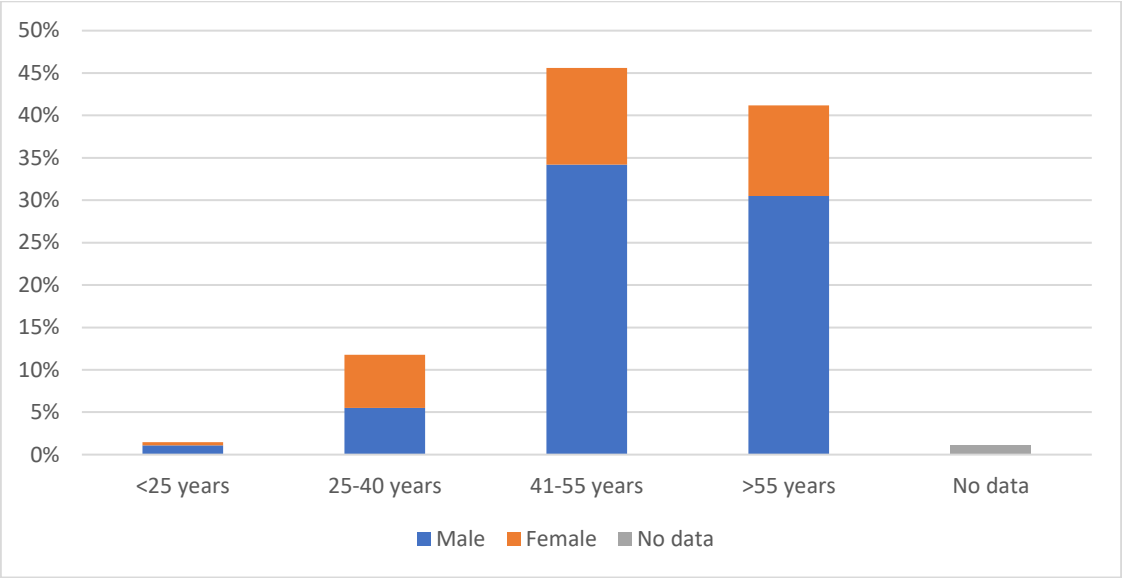
Source: United Nations Geospatial. 2007. Map of Bosnia and Herzegovina. https://www.un.org/geospatial/content/bosnia-and-herzegovina

Number of years farmers spent working with livestock

- Median: 30 years
- Range: 5–61 years

Age and gender of farmers

Figure 2. Age and gender distribution of farmers participating in the survey (Total: 275 farmers)



Source: Authors' own elaboration.

More than 85 percent of farmers surveyed were over the age of 40. Male farmers represented the majority (71.3 percent) of farmers in Bosnia and Herzegovina. Women were involved in the farming of all animal species in the surveyed entities, but their involvement was least common in sheep and goat farming. Women most commonly had backyard farms, while men mainly worked on commercial farms.

Farm record availability

Among the various records available, animal births were most frequently recorded on the surveyed farms (57.8 percent), followed by the amount of animals, eggs or milk sold (42.6 percent) and the amount of feed purchased (39.3 percent). Only two farmers (0.7 percent) had records of all animal health related data (medicines purchased, treatments, vaccinations, treatment protocols, veterinary visits, prescriptions, and mortality). Detailed responses to this part of the survey can be found in Annex 4.

Animals on the surveyed farms

Distribution and number of animal species on the surveyed farms

A large percentage of surveyed farms (90.9 percent) housed multiple species, regardless of the farming type (backyard, semi-commercial or large commercial). Among these, 39.6 percent were backyard farms, 58.8 percent were semi-commercial and 1.6 percent were large commercial farms.

Note: In this context, dairy and beef cattle, broiler and layer chickens, as well as horses for meat, milk and work were counted separately.

Average number of animals on farms at the time of the survey

Backyard farms

Among the surveyed backyard farms, most housed two to four different animal species (84.9 percent). Keeping only one species was not common (6.6 percent of farms.) The highest number of different animal species per farm was seven (0.9 percent of farms).

Note: In this context, dairy and beef cattle, broiler and layer chickens, as well as horses for milk and work were counted separately.

The ratio of backyard farms housing different animal species, and the average number of animals on these farms can be seen in the table below.

Table 2. Species distribution of the surveyed backyard farms (Total: 106 farms)

Species	Ratio of farms housing this species	Average no. of young animals (incl. range)	Average no. of adult animals (incl. range)	Farms
Dairy cattle	85.9%	1.6 (1–6)	2.0 (1–9)	91
Layer chickens	72.6%	10 (5–20)	15.0 (3–200)	77
Pigs	35.9%	1.1 (1–2)	1.7 (1–4)	38
Sheep	34.0%	6.1 (1–25)	13.2 (3–45)	36
Bees (beehives)	24.5%	3.3 (1–7)	12.8 (1–78)	26
Beef cattle	21.7%	1.6 (1–6)	5.7 (1–12)	23
Broiler chickens	12.3%	10.6 (5–30)	68.0 (5–200)	13
Goats	11.3%	3.8 (1–7)	4.3 (1–12)	12
Turkeys	3.8%	5.5 (5–6)	4.5 (4–5)	4
Ducks	2.8%	0	5.0 (2–8)	3
Horses for work	2.8%	0	2.0 (2–2)	3
Horses for milk	1.9%	0	1.5 (1–2)	2

Source: Authors' own elaboration.

No geese, rabbits or horses for meat were kept on the surveyed backyard farms. Dairy cattle and layer chickens were the most commonly housed species, among which layer chickens were kept in the largest groups, but there was a high variation in the number of animals per farm.

Semi-commercial farms

Among the surveyed semi-commercial farms, 9.8 percent housed only one animal species, which were beef cattle or broiler chickens in most cases (four farms for each species). More farms (23.2 percent) kept two species together, most commonly dairy and beef cattle and only 12.2 percent housed three species, which usually included dairy cattle with layer chickens and sheep. Most of the farms (54.3 percent) kept four or more species together, with dairy cattle and layer chickens present on almost all of them. The highest number of different animal species per farm was seven.

Note: In this context, dairy and beef cattle, broiler and layer chickens, as well as horses for meat and work were counted separately.

The ratio of semi-commercial farms housing different animal species, and the average number of animals on these farms can be seen in the table below.

Table 3. Species distribution of the surveyed semi-commercial farms (Total: 164 farms)

Species	Ratio of farms housing this species	Average no. of young animals (incl. range)	Average no. of adult animals (incl. range)	Farms
Dairy cattle	88.4%	3.2 (1–12)	6.6 (1–32)	145
Beef cattle	62.2%	6.7 (1–20)	9.2 (1–25)	102
Layer chickens	59.8%	8.8 (5–20)	21.2 (4–200)	98
Pigs	42.1%	50.6 (1–155)	24.3 (1–111)	69
Sheep	41.5%	16.3 (1–150)	26.1 (5–140)	68
Bees (beehives)	21.3%	2.3 (2–3)	9.5 (2–18)	35
Broiler chickens	19.5%	90.8 (10–300)	82.1 (10–200)	32
Goats	7.3%	13.2 (2–50)	20.2 (1–160)	12
Turkeys	3.7%	0	3.7 (2–6)	6
Geese	0.6%	3.0 (3–3)	3.0 (3–3)	1
Horses for meat	0.6%	0	10.0 (10–10)	1
Horses for work	0.6%	1.0 (1–1)	0	1

Source: Authors' own elaboration.

No ducks, horses for milk or rabbits were kept on the surveyed semi-commercial farms. Dairy cattle and beef cattle were kept on the highest number of semi-commercial farms, followed by layer chickens and pigs. Chickens were kept in the largest groups, but there was a high variation in the number of chickens, sheep and pigs. There was a noticeable difference in the average number of animals on semi-commercial farms compared to backyard farms, especially in case of chickens, pigs, and ruminants.

Large commercial farms

The survey was conducted in only four large commercial farms. Two species were represented on two farms (50.0 percent). On one farm (25.0 percent) three different animal species were kept and on the fourth farm (25.0 percent) four different species were housed.

Note: In this context, dairy and beef cattle, as well as broiler and layer chickens were counted separately.

The ratio of large commercial farms housing different animal species, and the average number of animals on these farms can be seen in the table below.

Table 4. Species distribution of the surveyed large commercial farms (Total: 4 farms)

Species	Ratio of farms housing this species	Average no. of young animals (incl. range)	Average no. of adult animals (incl. range)	Farms
Beef cattle	100%	23.5 (6–40)	26.3 (14–40)	4
Dairy cattle	75.0%	12.0 (12–12)	29.0 (2–68)	3
Layer chickens	50.0%	0	20.0 (20–20)	2
Broiler chickens	25.0%	0	15.0 (15–15)	1
Sheep	25.0%	0	15.0 (15–15)	1
Pigs	25.0%	10.0 (10–10)	40.0 (40–40)	1
Bees (beehives)	25.0%	0	3.0 (3–3)	1

Source: Authors' own elaboration.

No geese, ducks, turkeys, horses, goats or rabbits were kept on the surveyed large commercial farms. Beef cattle were kept on the highest number of large commercial farms, and these were kept in the largest groups.

The survey covered only one government farm (housing dairy cattle) which housed 90 calves and 40 cows.

General information on AMU

Knowledge about antibiotics: self-evaluation

Most farmers knew what antibiotics are:

- Yes: 215 (78.2 percent)
- No: 60 (21.8 percent)

Among farmers not knowing what antibiotics are, all age groups and both genders were included, and the years they spent in livestock ranged between 5 and 50 years. The percentage of women who had knowledge about antibiotics was lower than the percentage of men.

Table 5. Farmers' knowledge of antibiotics by gender

Gender	Ratio of farmers knowing antibiotics
Female (n=79)	53.9%
Male (n=196)	88.2%

Source: Authors' own elaboration.

Table 6. Farmers' knowledge of antibiotics by age group

Age group	Ratio of farmers knowing antibiotics
Under 25 years (n=4)	75.0%
25–40 years (n=32)	81.3%
41–55 years (n=126)	87.1%
Over 55 years (n=113)	67.5%

Source: Authors' own elaboration.

Table 7. Farmers' knowledge of antibiotics by experience in livestock farming

Experience in livestock farming	Ratio of farmers knowing antibiotics
≤ 10 years of experience (n=11)	72.7%
11–20 years of experience (n=51)	88.2%
21–30 years of experience (n=95)	76.8%
> 30 years of experience (n=118)	75.4%

Source: Authors' own elaboration.

Knowledge about antibiotics: by definition

Among those who claimed to know what an antibiotic is, 40.4 percent chose the right definition only ("medicine that kills bacteria") from the list provided. Other answers were as follows:

- "medicine that kill germs" ..... 83 (38.6 percent)
- "medicine that kill diseases" ..... 71 (33.0 percent)
- "medicine that kills viruses" ..... 22 (10.2 percent)
- "medicine that kills parasites" .....13 (6.1 percent)
- "medicine that prevents diseases".....9 (4.2 percent)
- "medicine that makes animals grow faster/bigger" .....6 (2.8 percent)

Note: Only farmers saying "Yes" to the previous question were included in this part. It was possible to choose more than one response to this question.

Use of antibiotics

When farmers were asked "Do you use antibiotics?", the following answers were collected:

- Yes: 112 (40.7 percent)
- No: 163 (59.3 percent)

The relationship between antibiotic use and different demographic data is summarized below.

Relationship with education data

The ratio of antibiotic users among farmers with different types of education were as follows:

Table 8. Distribution of antibiotic users among farmers with different education levels

Education/training type	Antibiotic users	Non-antibiotic users
Animal health (n=69)	58.0%	42.0%
Animal husbandry (n=106)	50.0%	50.0%
Pharmacology (n=14)	50.0%	50.0%
Without education (n=148)	35.1%	64.9%

Source: Authors' own elaboration.

Farmers with education or training on animal health or other related areas were more likely to use antibiotics than farmers without education.

Note: Some farmers had more than one type of education or training.

Relationship with farming type

Farmers at different farm types used antibiotics in the following ratio:

Table 9. Distribution of antibiotic users among farmers of different farming types

Farm type	Ratio of farmers using antibiotics
Large commercial (n=4)	100%
Semi-commercial (n=164)	48.8%
Government (n=1)	100%
Backyard (n=106)	25.5%

Source: Authors' own elaboration.

Antibiotics were not used on most (74.5 percent) backyard farms. , Approximately half of the semi-commercial farms used them (48.8 percent) and all surveyed large and state farms (4 large farms and 1 state farm were surveyed).

Relationship with age and experience in livestock farming

Farmers of different ages and years of experience in livestock farming used antibiotics in the following ratio:

Table 10. Distribution of antibiotic users among farmers of different age groups

Age group	Ratio of farmers using antibiotics
Under 25 years (n=4)	25.0%
25–40 years (n=32)	50.0%
41–55 years (n=126)	41.1%
Over 55 years (n=113)	37.7%

Source: Authors' own elaboration.

Table 11. Distribution of antibiotic users among farmers with different experience in livestock farming

Experience in livestock farming	Ratio of farmers using antibiotics
≤ 10 years of experience (n=11)	36.4%
11–20 years of experience (n=51)	47.1%
21–30 years of experience (n=95)	32.6%
> 30 years of experience (n=118)	44.9%

Source: Authors' own elaboration.

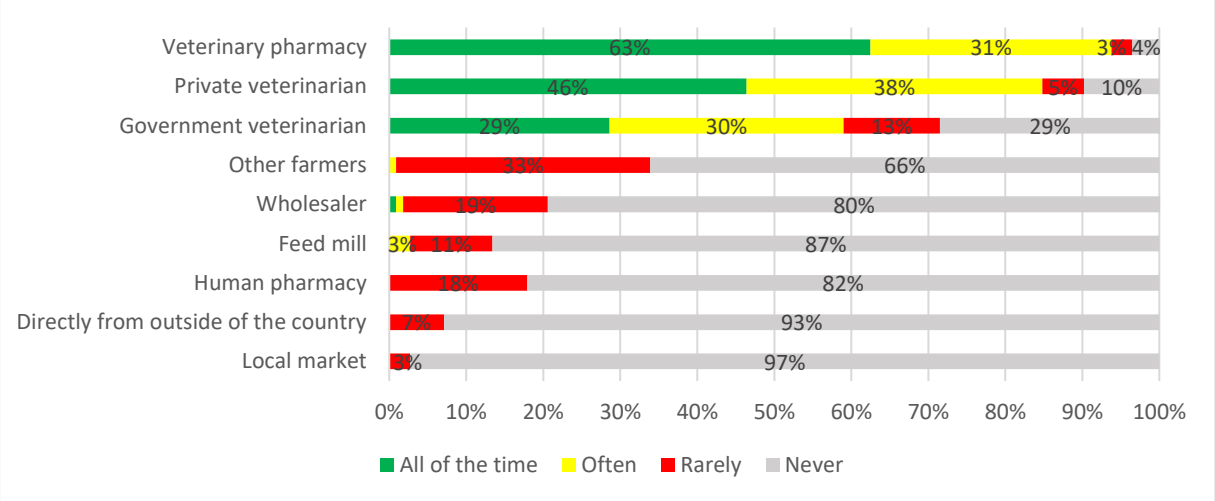
There was no notable difference in terms of antibiotic use between farmers of different age and experience.

Note: Among those who reported not knowing what antibiotics are, four used them.

The following AMU related questions only include answers from farmers using antibiotics (112 surveys).

Common sources of antibiotics

Figure 3. Antibiotic sources of farmers (Total: 111 of 112 farmers replied)

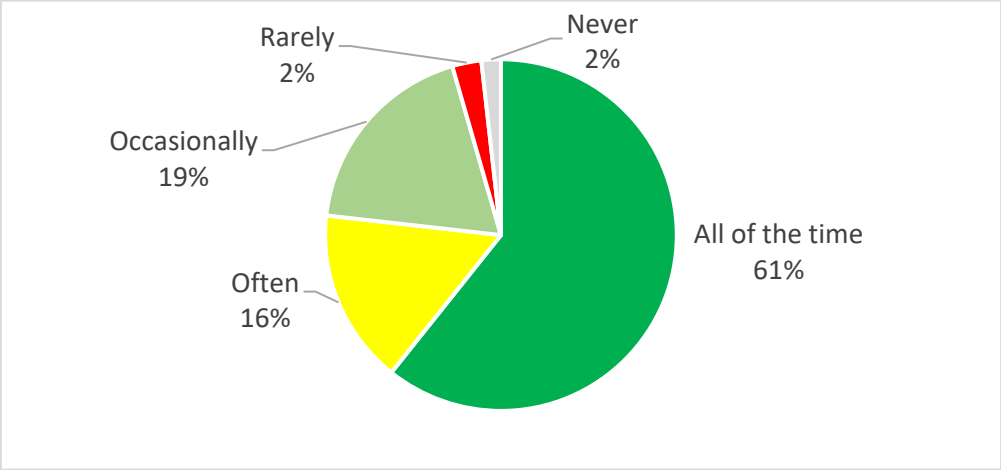


Source: Authors' own elaboration.

Antibiotics were most frequently purchased from veterinary pharmacies or private and government veterinarians in the country, while wholesalers, human pharmacies, local markets, feed mills, other countries and other farmers were less common sources. Most farmers never obtained antibiotics from outside of the country (92.9 percent) or from the local market (97.3 percent). Also, most farmers did not obtain antibiotics from human pharmacies (82.1 percent) or feed mills (86.6 percent).

Obtaining antibiotics with prescription

Figure 4. Frequency of prescription use for obtaining antibiotics among farmers (Total: 111 of 112 farmers replied)

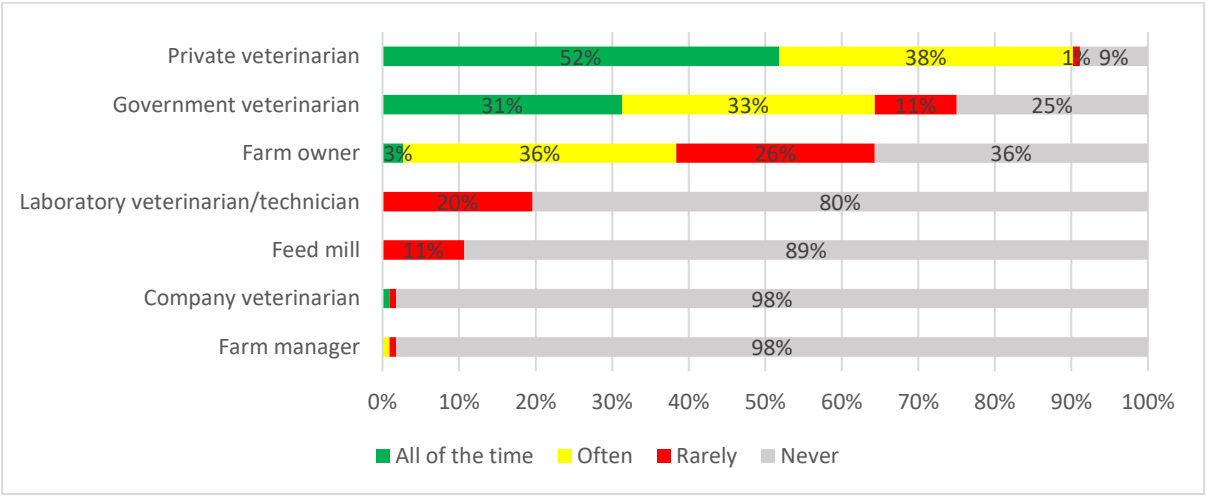


Source: Authors' own elaboration.

In most cases, antibiotics were obtained with prescriptions. More than half of the surveyed farmers (60.7 percent) always bought antibiotics with a prescription, while 16.1 percent often and 18.8 percent occasionally had a prescription for the purchase.

Who makes the decision on when to use an antibiotic?

Figure 5. Decision making on antibiotic use at the surveyed farms (Total: 111 of 112 farmers replied)

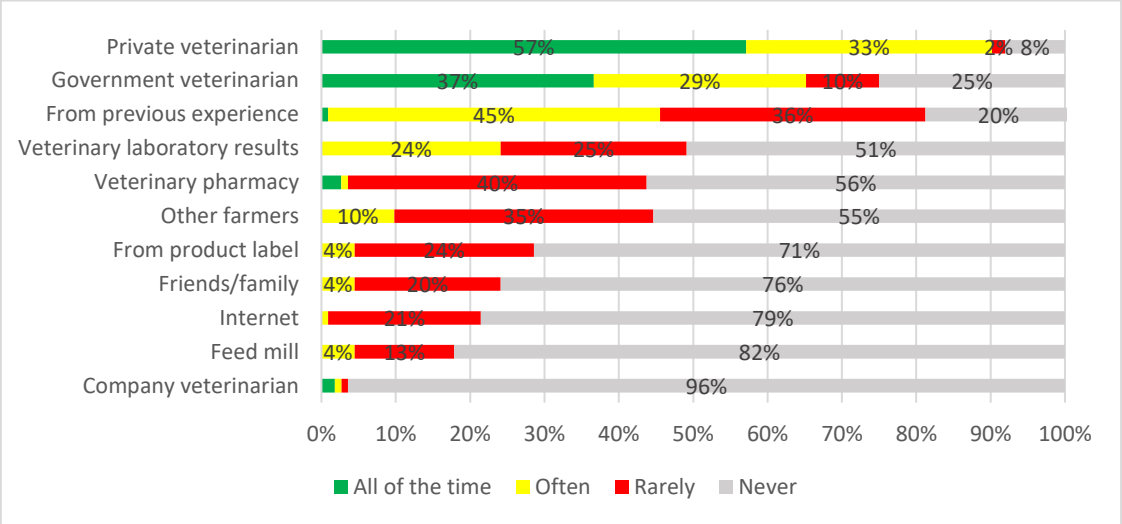


Source: Authors' own elaboration.

On the surveyed farms, the decision to use antibiotics was most commonly made by private or state veterinarians. Farm owners often decided on the use antibiotics on 35.7 percent of farms, and occasionally on 25.9 percent.

Sources of advice or information on which antibiotics, dose and duration of treatment to use for specific problems

Figure 6. Sources of advice on antibiotic use at the surveyed farms (Total: 111 of 112 farmers replied)



Source: Authors' own elaboration.

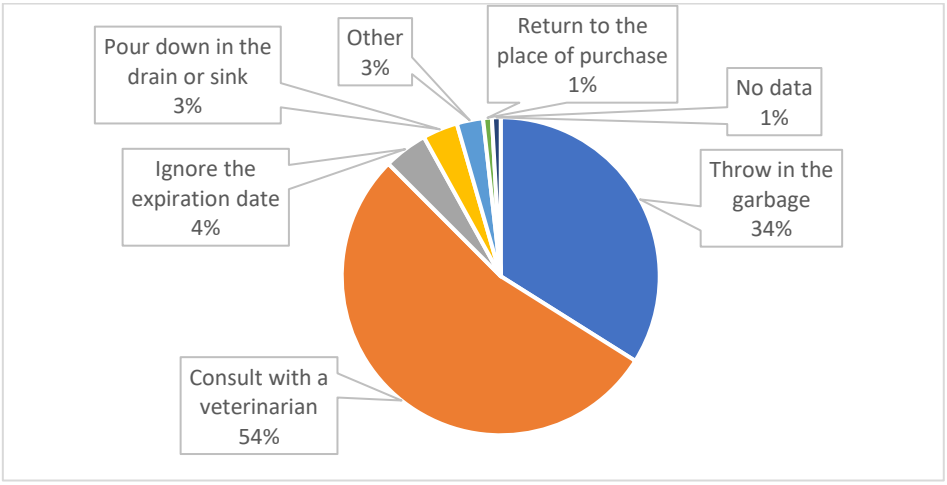
Farmers usually got advice on what antibiotic to use from private and government veterinarians. Their previous experience was also frequently taken into account. Advice from veterinary pharmacies, other farmers and veterinary laboratory results were considered by fewer farmers and in only a small number of cases. Company veterinarians, the Internet, friends and family, feed mills and product labels were not commonly used sources of information.

Use of antibiotics as advised

Almost all farmers (92.0 percent) used antibiotics as advised in terms of dose, but only 82.1 percent of farmers followed the advice regarding the length of treatment. Some farmers (15.2 percent) gave antibiotics for longer than prescribed, while others (1.8 percent) stopped treatment earlier.

Handling after expiration

Figure 7. Handling of expired antibiotics on the surveyed farms (Total: 111 of 112 farmers replied)



Source: Authors' own elaboration.

After expiration of antibiotics, most surveyed farmers reported consulting with a veterinarian (53.6 percent) or throwing them in the garbage (33.9 percent). From farmers who chose the "Consult with a veterinarian" option, 54.7 percent consulted with private veterinarians, 11.7 percent with government veterinarians, and 36.7 percent with both.

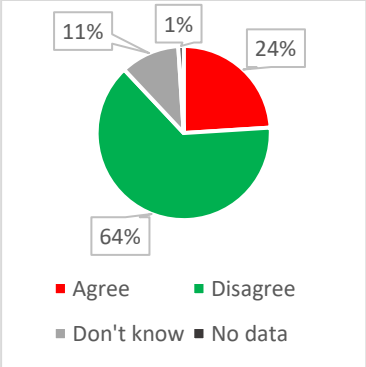
Knowledge on AMU and AMR

Several questions were asked in the survey to assess to knowledge of farmers on AMU and AMR. A total of 63.4 percent of farmers reported having heard about AMR. Further responses are summarised in Figure 8.

Figure 8. Farmers' responses to questions assessing their knowledge of AMU and AMR (Total: 111 of 112 farmers replied)

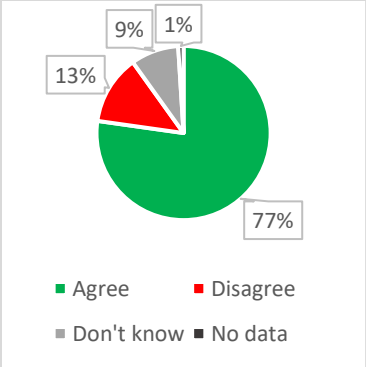
Q1. You can stop giving antibiotics to an animal if their symptoms are improving.

Correct answer: Disagree



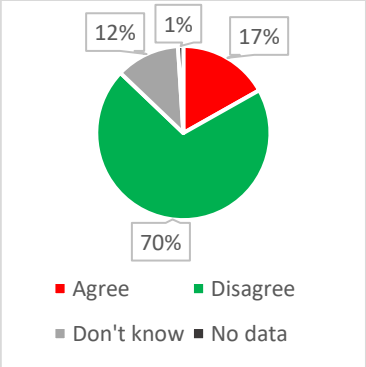
Q2. If antibiotics are given too often, they might stop working

Correct answer: Agree



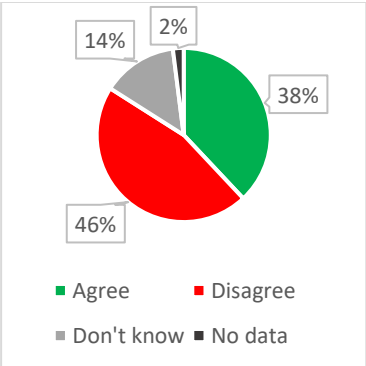
Q3. Giving antibiotics to healthy animals will prevent them from getting sick in the future.

Correct answer: Disagree



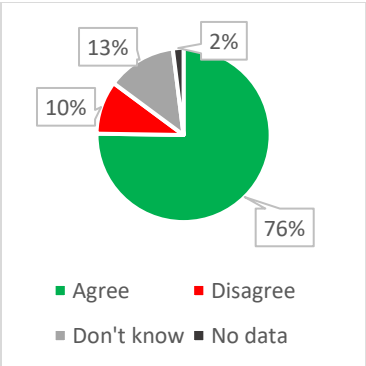
Q4. Using vaccines can prevent the use of antibiotics.

Correct answer: Agree



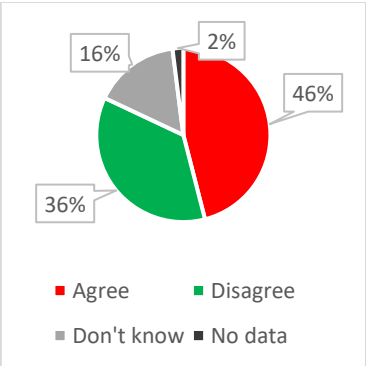
Q5. Animals can transmit disease to humans.

Correct answer: Agree



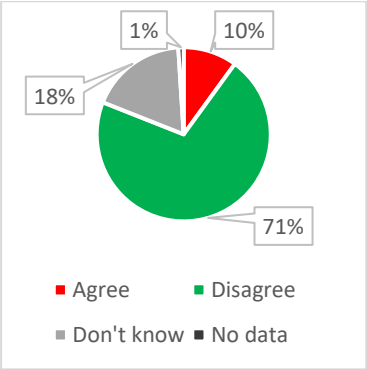
Q6. Antibiotic use in animals does not affect human health.

Correct answer: Disagree



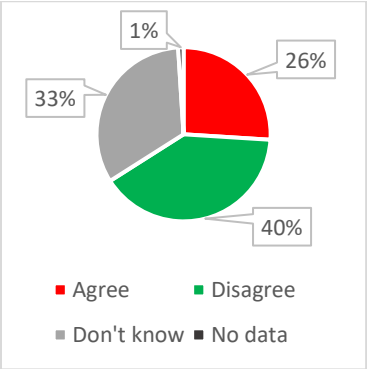
Q7. Antibiotics may be freely discarded without having an action/effect on the environment.

Correct answer: Disagree



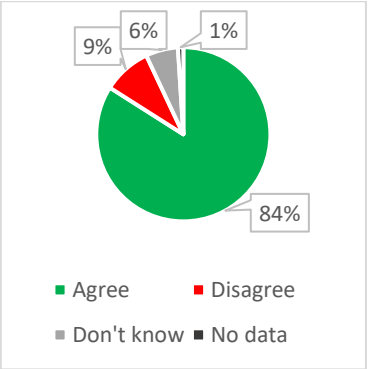
Q8. Antibiotic resistance occurs when antibiotics are found in the meat or milk of an animal.

Correct answer: Disagree



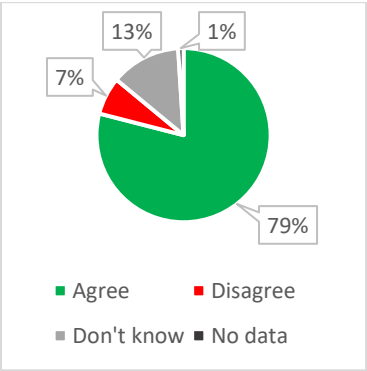
Q9. When you use antibiotics there is a certain number of days you should wait before selling the animals for slaughter, selling eggs, milk or honey.

Correct answer: Agree



Q10. With prevention and early detection, you can reduce the use of antibiotics.

Correct answer: Agree



Source: Authors' own elaboration.

Except for Q4, Q6 and Q8, the majority of farmers answered these questions correctly. It is interesting to note that even though most farmers knew that antibiotics cannot be freely discarded without having an effect on the environment (Q7), many of them reported throwing expired antibiotics into the garbage.

In total, ten questions were asked about AMU and AMR in the above section (Figure 8). The average number of correct answers given was 7.0 among all the surveyed farmers. The average values in the different groups are presented below. Female, younger and less experienced farmers, and those who did not have previous education or training scored worst.

Table 12. Farmers' knowledge on AMU and AMR by gender

Gender	Average number of correct answers
Female (n=23)	5.2
Male (n=89)	7.4

Source: Authors' own elaboration.

Table 13. Farmers' knowledge on AMU and AMR by age

Age	Average number of correct answers
Under 25 years (n=1)	11.0
25–40 years (n=16)	4.9
41–55 years (n=52)	7.3
Over 55 years (n=43)	7.5

Source: Authors' own elaboration.

Table 14. Farmers' knowledge on AMU and AMR by experience in livestock farming

Experience in livestock farming	Average number of correct answers
≤ 10 years (n=4)	5.3
11–20 years (n=24)	6.2
21–30 years (n=31)	6.6
> 30 years (n=53)	7.5

Source: Authors' own elaboration.

Table 15. Farmers' knowledge on AMU and AMR by education

Previous education/training related to livestock farming	Average number of correct answers
Yes (n=60)	7.5
No (n=52)	6.5

Source: Authors' own elaboration.

Table 16. Farmers' knowledge on AMU and AMR by farming type

Farm type	Average number of correct answers
Backyard (n=27)	7.3
Semi-commercial (n=80)	6.8
Large commercial (n=4)	8.8
Government Farm (n=1)	9.0

Source: Authors' own elaboration.

Change in the efficacy of antibiotics – farmers' experience

Of the surveyed farmers, 79.5 percent thought that antibiotics are as effective as they were in the past, while 12.5 percent of them experienced slightly decreased efficacy. No farmer reported that these drugs are much less effective than previously, and only 0.9 percent reported that antibiotics were effective if they used higher doses than previously. Some (6.3 percent) farmers chose the option "I don't know".

Farmers' interest in learning more about antibiotics

Less than half (39.3 percent) of farmers were interested in learning more about antibiotics.

Impact of COVID-19

During or after the COVID-19 lockdown, 17.0 percent of farmers experienced problems accessing veterinary support. This was reflected in all areas that depend on veterinary visits: 6.3 percent of farmers experienced problems accessing vaccines and 3.6 percent faced problems accessing antibiotics. Also, 3.6 percent of farmers declared that they had problems accessing disinfectants at the beginning of the lockdown since they are imported goods, and the country had problems with transport from other countries, while at the same time the demand suddenly increased significantly.

DAIRY FARMS

Number of surveys: planned 100, completed 102

Note: The survey was conducted during the period of intense seasonal labour on the farms, so interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked, but were not surveyed, were not recorded. There were also cases when the survey was started and after some time, given the large number of questions, farmers quit and did not answer all the survey questions.

Information on farms involved in the survey

Number of animals on the surveyed farms (last 12 months)

Table 17. Number of animals on the surveyed dairy farms (Total: 102 farms)

	Average	Minimum	Maximum
Cows (milking and dry)	10.0	2	120
Bulls	4.0	2	9
Calves under 6 months	3.7	0	20
Heifers (animals of more than 6 months, that have not calved yet)	6.2	1	55

Source: Authors' own elaboration.

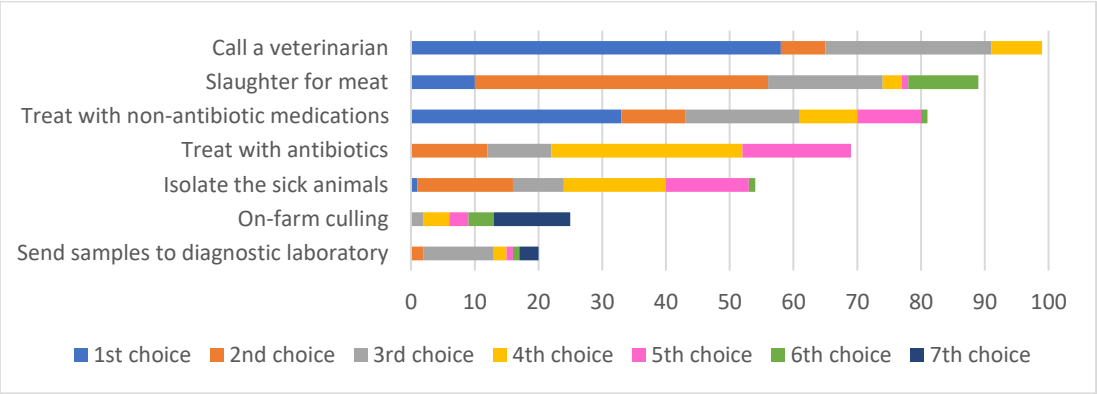
The grazing or feeding place during the day

Figure 9. Grazing place of dairy cattle on the surveyed farms (Total: 101 of 102 farmers replied)

Source: Authors' own elaboration.

Measures in case of disease

Figure 10. Measures in case of disease on the surveyed dairy farms (Total: 102 farms)

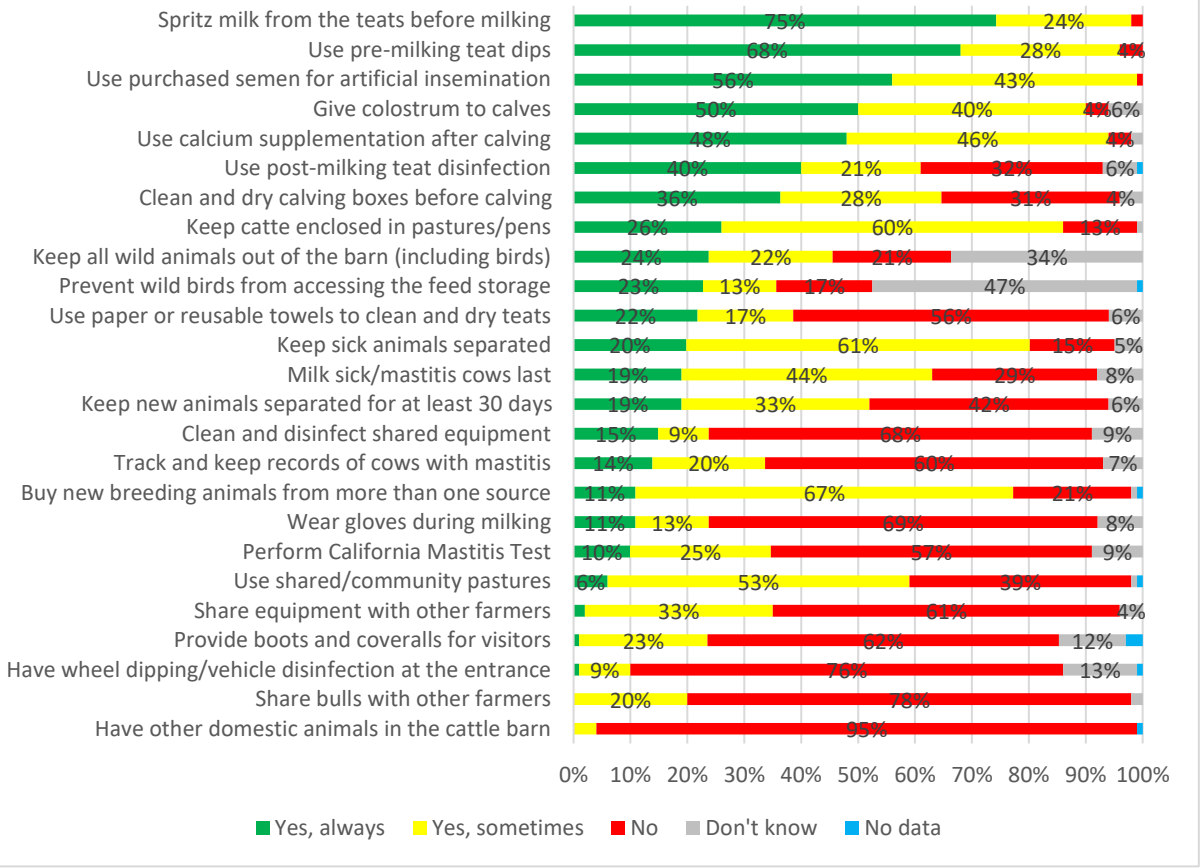


Source: Authors' own elaboration.

In case of disease, calling a veterinarian was the most common first choice measure in dairy farms. Treatment with non-antibiotic medications was also frequently performed. Slaughtering animals for meat was usually a second-choice measure. These were followed by isolating the sick animals and treatment with antibiotics. Sending samples to the diagnostic laboratory and on-farm culling were least common. Two farmers did not report doing any of the listed measures.

Hygiene and biosecurity

Figure 11. Hygiene and biosecurity measures on the surveyed dairy farms (Total: 102 farms)



Source: Authors' own elaboration.

Around 90 percent of the farmers reported giving colostrum to the calves either always or sometimes. The time of giving colostrum, after calving, varied from 1 to 4 hours (on average 1.6 hours). The duration of suckling was from 3 to 30 minutes, and was, on average, 11.4 minutes. Around 75 percent of farmers always spritzed milk before milking, and 68 percent always used pre-milking teat dips, but only 40 percent used post-milking disinfection regularly. Many of them did not use paper towels for drying and cleaning the teat before milking, and only 19 percent reported always milking cows with mastitis last. This may be explained by the fact that around 60 percent of farmers never kept record of cows with mastitis. Although almost all farmers (95 percent) reported not having other domestic animals in the cattle barn, keeping wild animals away was less common. Cleaning and drying calving boxes was only practiced by 64 percent of farmers. Keeping new and sick animals separately was not a regular measure on many farms. Providing boots and coveralls for visitors and having wheel or vehicle disinfection at the entrance were very rare.

Mortality due to disease (last 12 months)

The average mortalities recorded on the surveyed farms are summarized in the table below.

Table 18. Mortality on the surveyed dairy farms (Total: 91 of 112 farmers replied)

	Average	Range
Cows (milking and dry)	7.2%	1–15%
Calves under 6 months	9.5%	1–20%
Heifers	10.0%	10%

Source: Authors' own elaboration.

Occurrence and severity of health issues or syndromes (last 12 months)

Occurrence and severity of certain health issues are presented in the table below.

Table 19. Health issues on the surveyed dairy farms (Total: 71 of 102 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Calves under 6 months	Diarrhoea	14.7%	17.7% (1–50%)	10.0% (0–60%)
	Nervous system problems	10.8%	14.3% (2–20%)	44.5% (0–100%)
	Foot rot	1.0%	20.0%	2.0%
	Breathing problems	4.9%	20.0% (10–50%)	7.5% (0–20%)
	Other intestinal problems	3.9%	23.0% (2–50%)	7.5% (0–20%)
	Other	2.0%	11.0% (2–20%)	100%
Heifers	Foot rot	2.9%	10.0% (10%)	0.7% (0–2%)
	Other intestinal problems	1.0%	10.0%	-
	Other	1.0%	10.0%	100%
Cows	Mastitis	42.2%	29.8% (10–50%)	2.5% (0–10%)
	Foot rot	27.5%	19.9% (5–30%)	0.9% (0–10%)
	Diarrhoea	11.8%	15.0% (10–20%)	0.4% (0–5%)
	Metritis	9.8%	14.3% (3–30%)	6.3% (0–30%)
	Other lameness	4.9%	17.0% (5–30%)	-

Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Reproductive problems	3.9%	6.8% (1–15%)	50.0% (50%)
Other	3.9%	10.8% (8–15%)	100% (100%)
Other intestinal problems	2.9%	14.0% (2–20%)	5.0% (0–10%)
Breathing problems	2.9%	16.7% (15–20%)	-
Nervous system problems	1.0%	5.0%	20.0%

Source: Authors' own elaboration.

On the surveyed farms, cows were most frequently affected with health issues or syndromes, and the most common problems were mastitis and foot rot. The table also shows the option "Other" for all three categories. Under this option, farmers cited reasons such as sudden death during the night, snake bite, foreign object in the stomach or death because the animal ate something in the pasture. None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19.

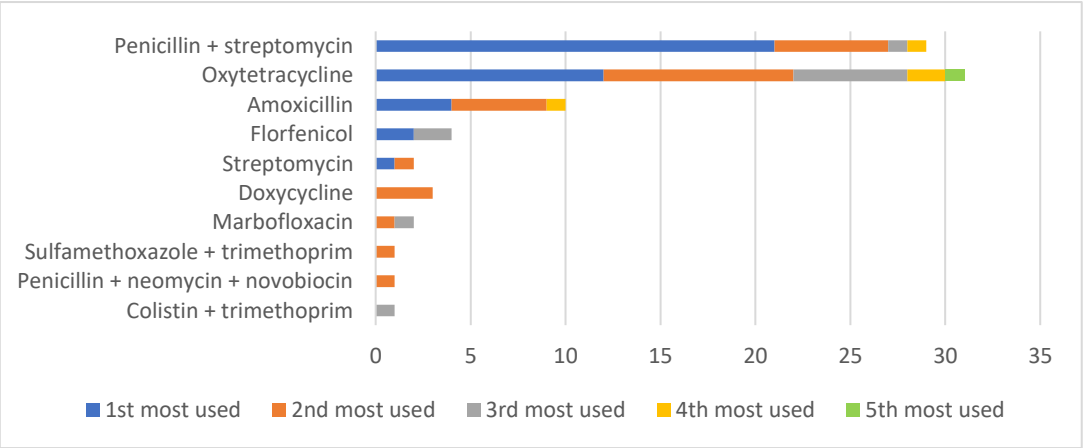
Vaccination was not a common practice. Farmers stated that they applied it only in the following cases: against breathing problems in calves under 6 months on one farm and against metritis in cows on one farm.

Information on AMU

On the surveyed dairy farms, 45.1 percent of farmers did not use antimicrobials at all. The rest of the farmers (54.9 percent) reported different proportions of their animals being treated with antimicrobials. Only one farmer (1.0 percent) reported using antibiotics for enhancing growth or production in less than 5 percent of animals. A small percentage of the surveyed farmers (2.0 percent) treated dry cows. These farmers used oxytetracycline injections, in less than 5 percent of animals.

On the surveyed dairy farms, 56 farmers indicated that they used antibiotics. Thirteen farmers reported using only one drug, 16 reported using two, seven farmers reported using three, three farmers reported using four and one farmer reported using five different substances. The rest (16 farmers) did not specify any medicine, as antibiotics were administered only by the veterinarians on their farms. The most frequently used antimicrobials were as follows:

Figure 12. Most used antimicrobials on the surveyed dairy farms (Total: 56 of 102 farmers replied)



Source: Authors' own elaboration.

The most frequently used antibiotics were penicillin and streptomycin (used in combination). All farmers used these drugs for the treatment of mastitis. The medicine was given by injection for 5 days. If the treatment did not yield the expected results, 86.4 percent farmers called the veterinarian, 4.6 percent repeated the treatment with the same antibiotic, and 4.6 percent took a blood sample for antibiotic susceptibility testing.

The second most commonly used active substance was oxytetracycline. Farmers used this medicine to treat diseases such as: foot rot, diarrhoea and other intestinal problems, lameness, metritis, and mastitis. It was used mainly as a treatment, with only one farmer using it for the prevention of foot rot. Depending on the health issue, oxytetracycline was applied as an injection, in water, or topically, for 5 to 7 days. If the applied treatment did not yield the expected results, 60 percent of farmers called the veterinarian, 20 percent reported using another antibiotics and 20 percent reported slaughtering the animal for meat.

The above-mentioned drugs were given mostly to adult animals.

BEEF FARMS

Number of surveys: planned 100, completed 108

Note: The survey was conducted during the period of intense seasonal labour on the farms, so interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked, but were not surveyed, were not recorded. There were also cases when the survey was started and after some time, given the large number of questions, farmers quit and did not answer all the survey questions.

Information on farms involved in the survey

Number of animals on the surveyed farms (last 12 months)

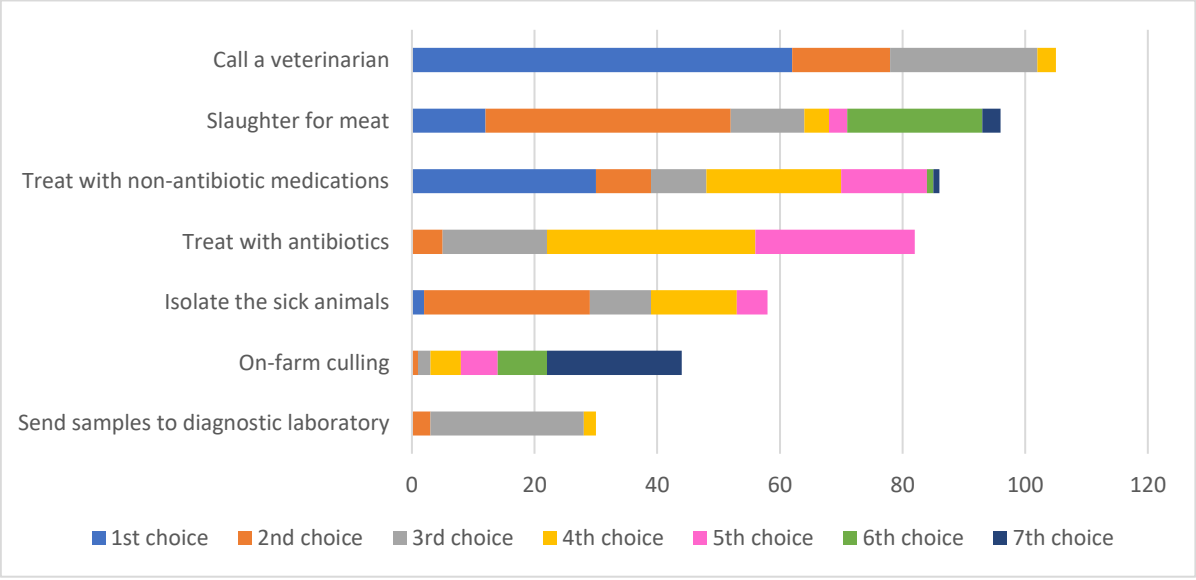
Table 20. Number of animals on the surveyed beef farms (Total: 107 of 108 farmers replied)

	Average	Minimum	Maximum
Cows	7.0	1	18
Bulls	7.6	1	80
Calves under 6 months	5.2	1	48
Young cattle (heifers or steers) over 6 months	8.6	1	22

Source: Authors' own elaboration.

Measures in case of disease

Figure 13. Measures in case of disease on the surveyed beef farms (Total: 107 of 108 farmers replied)



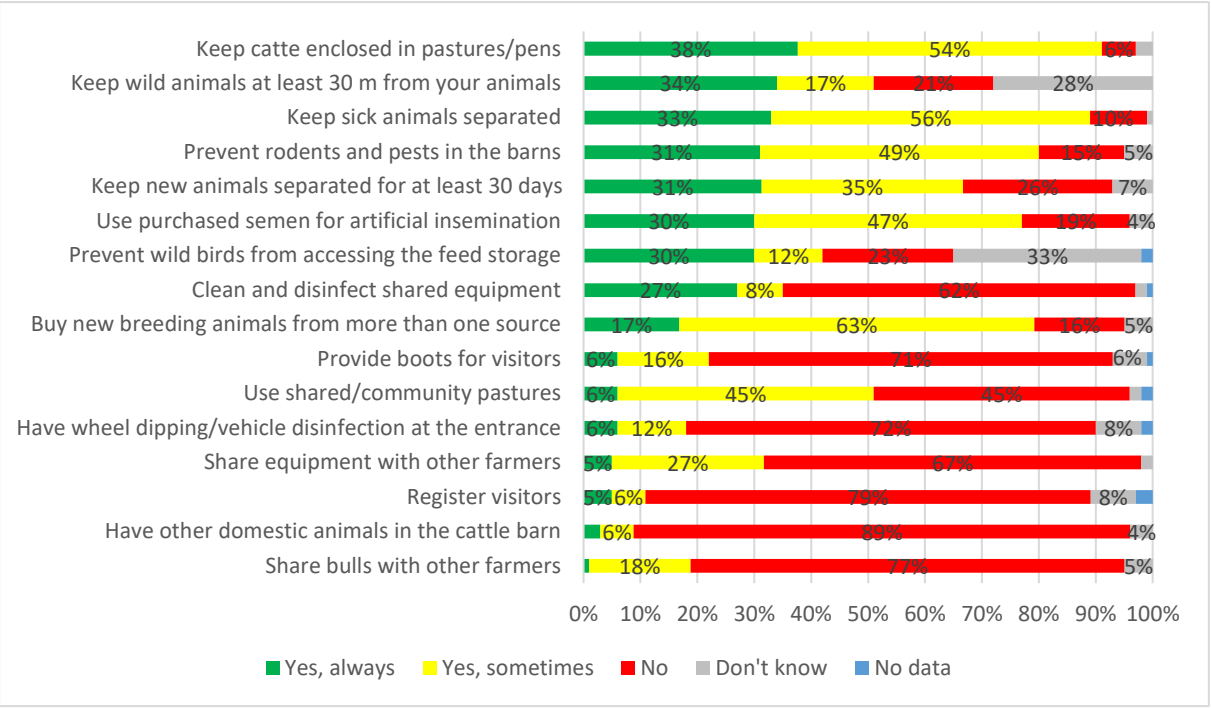
Source: Authors' own elaboration.

In case of disease, calling a veterinarian was the most common first choice measure on beef farms. Treatment with non-antibiotic medications was also frequently performed as was slaughtering animals for meat. Treatment with antibiotics was reported by many farmers, but only as a fourth or fifth choice in most cases. Around half of the farmers would isolate the sick animals in case of disease, mainly as a second or later choice. Sending samples to the diagnostic laboratory was

usually a third choice, but was not practiced by many farmers. On-farm culling was mainly the last choice. Two farmers did not report taking any of the listed measures.

Hygiene and biosecurity

Figure 14. Hygiene and biosecurity measures on the surveyed beef farms (Total: 108 farmers)



Source: Authors' own elaboration.

The most commonly applied good measures were: keeping cattle enclosed in pastures or pens, keeping sick animals separated, preventing rodents and pests from entering the barn(s), and keeping new animals separated. However, many farmers practiced these only sometimes, and not always. Most farmers did not have other domestic animals in the barn, and did not share equipment or bulls with other farmers.

In addition to the measures taken, farmers should improve the following: having wheel dipping at the farm entrance and registering and providing boots for visitors. These practices were less commonly reported.

Mortality due to disease (last 12 months)

The average mortalities recorded on the surveyed farms are summarized in the table below.

Table 21. Mortality on the surveyed beef farms (Total: 16 of 108 farmers replied)

	Average	Range
Cows	0.1%	0–5%
Calves under 6 months	0.4%	0–10%
Heifers or steers over 6 months	2.0%	0–25%

Source: Authors' own elaboration.

Occurrence and severity of health issues or syndromes (last 12 months)

Occurrence and severity of certain health issues are presented in the table below.

Table 22. Health issues on the surveyed beef farms (Total: 66 of 108 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Calves under 6 months	Nervous system problems	10.2%	10.2% (2–20%)	47.8% (10–100%)
	Diarrhoea	8.3%	14.2% (3–30%)	10.0% (0–20%)
	Breathing problems	2.8%	14.0% (2–30%)	10.0% (0–10%)
	Other intestinal problems	1.8%	15.0% (10–20%)	25.0% (0–50%)
	Other	0.9%	10.0% (0–10%)	1.0% (0–100%)
Heifers	Foot rot	31.5%	18.2% (10–30%)	2.6% (0–10%)
	Diarrhoea	24.1%	13.4% (1–33%)	0.7% (0–10%)
	Breathing problems	13.0%	16.1% (1–30%)	8.0% (7–10%)
	Other intestinal problems	7.4%	14.4% (5–20%)	8.8% (0–50%)
	Nervous system problems	6.5%	8.6% (5–10%)	45.7% (20–50%)
	Other lameness	4.6%	16.0% (10–20%)	4.0% (0–10%)
	Other	2.8%	9.0% (2–15%)	83.3% (50–100%)
Cows	Foot rot	3.7%	45.0% (10–100%)	-
	Other intestinal problems	1.0%	10.0% (0–10%)	-

Source: Authors' own elaboration.

On the surveyed farms, heifers were most frequently affected with health issues or syndromes and the most common problems were foot rot, diarrhoea and breathing problems.

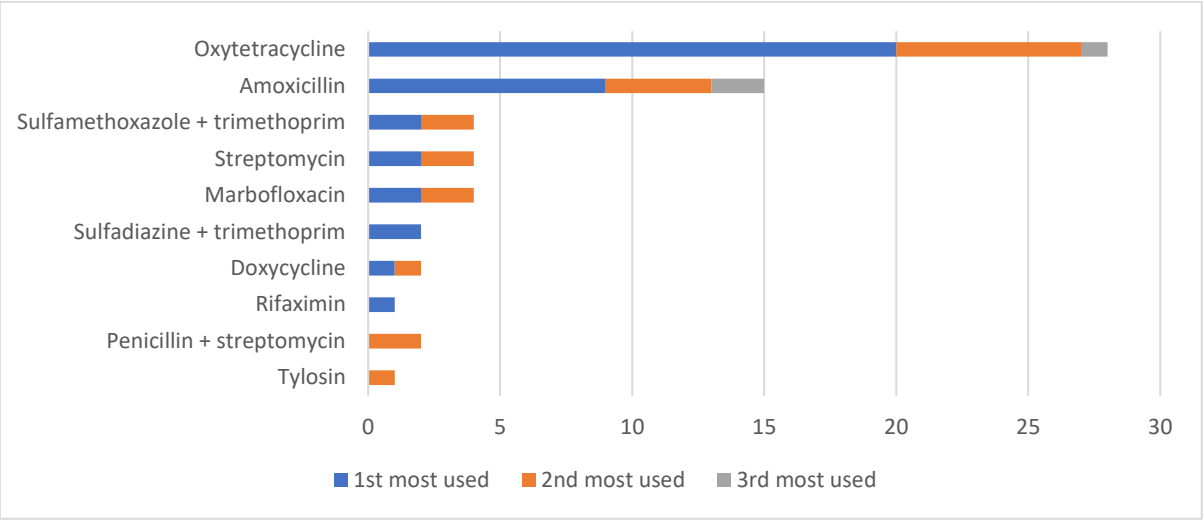
Table 22 also shows the option "Other" for two categories (calves under 6 months and heifers). Under this option, farmers cited reasons such as: sudden death by suffocation, foreign body in the stomach, and snake bite in the pasture.

None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19.

Information on AMU

On the surveyed beef farms, 44.4 percent of farmers did not use antimicrobials at all. The rest of the farmers (55.6 percent) reported different proportions of their animals being treated with antimicrobials, of which 25.6 percent farmers used only one, 25.6 percent used two and 4.3 percent used three different drugs. No farmer reported using antibiotics for growth promotion.

Figure 15. Most used antimicrobials on the surveyed beef farms (Total: 60 of 108 farmers replied)



Source: Authors' own elaboration.

The most commonly used antibiotic was oxytetracycline**.** Farmers used this medicine to treat diseases such as: foot rot, diarrhoea and other intestinal problems, and lameness. The antibiotic was used mainly as a treatment, with only one farmer using it to prevent foot rot. Depending on the disease, it was applied as an injection, in water, or topically for 4 to 7 days. Farmers reported that, on average, they treated 13.6 percent of animals with this substance. If the treatment did not yield the expected results, 55 percent of farmers called the veterinarian, 25 percent used a different antibiotic, 10 percent farmers repeated the treatment with the same antibiotic, 5 percent reported slaughtering the animal for meat, and 5 percent farmers did nothing.

The second most commonly used antibiotic was amoxicillin. Farmers used this medicine to treat diseases such as: breathing problems and diarrhoea. It was used mainly as a treatment, and most often applied as an injection or in water for 4 to 6 days. If the treatment did not yield the expected results, farmers consulted with a veterinarian. Drugs were mainly given to adult animals.

None of the farmers reported testing samples to identify the pathogen or waiting for antimicrobial susceptibility results from the laboratory.

SMALL RUMINANT FARMS

Number of surveys: planned 20, completed 30

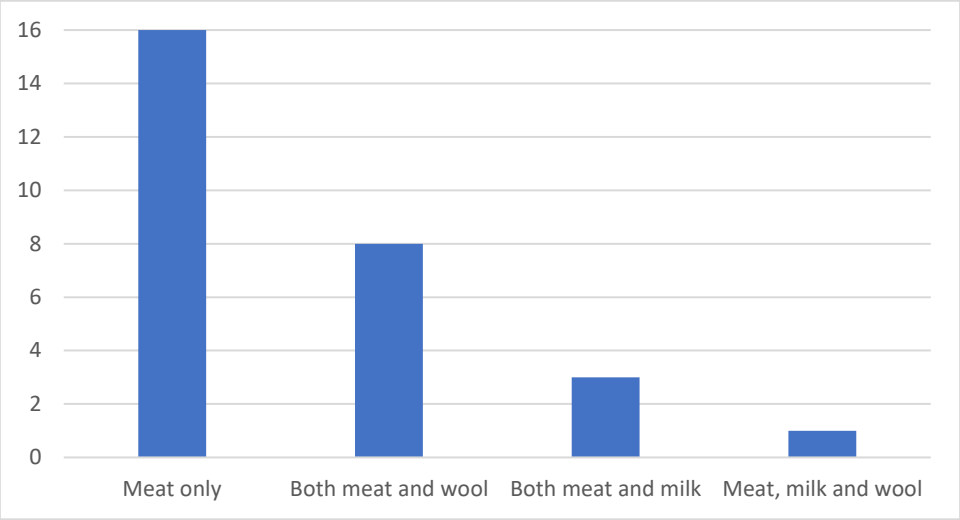
Note: The survey was conducted during the period of intense seasonal labour on the farms, so interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked, but were not surveyed, were not recorded. There were also cases when the survey was started and after some time, given the large number of questions, farmers quit and did not answer all the survey questions.

Information on farms involved in the survey

The survey included 30 farmers, out of which 24 farmers raised only sheep, two farmers raised only goats and four farmers raised both sheep and goats.

The purpose of raising sheep

Figure 16. Sheep raising purposes on the surveyed farms



Source: Authors' own elaboration.

Out of 28 farmers who raised sheep, 16 farmers raised sheep only for meat, eight farmers raised sheep for meat and wool, three farmers raised sheep for meat and milk, and only one farmer raised sheep for meat, milk and wool as well. No farmer raised sheep only for milk or only for wool.

Purpose of raising goats

Among the 30 surveyed farmers, six of them bred goats and raised them for meat and milk. No farmer kept goats just for meat or just for milk.

Number of animals on the surveyed farms (last 12 months)

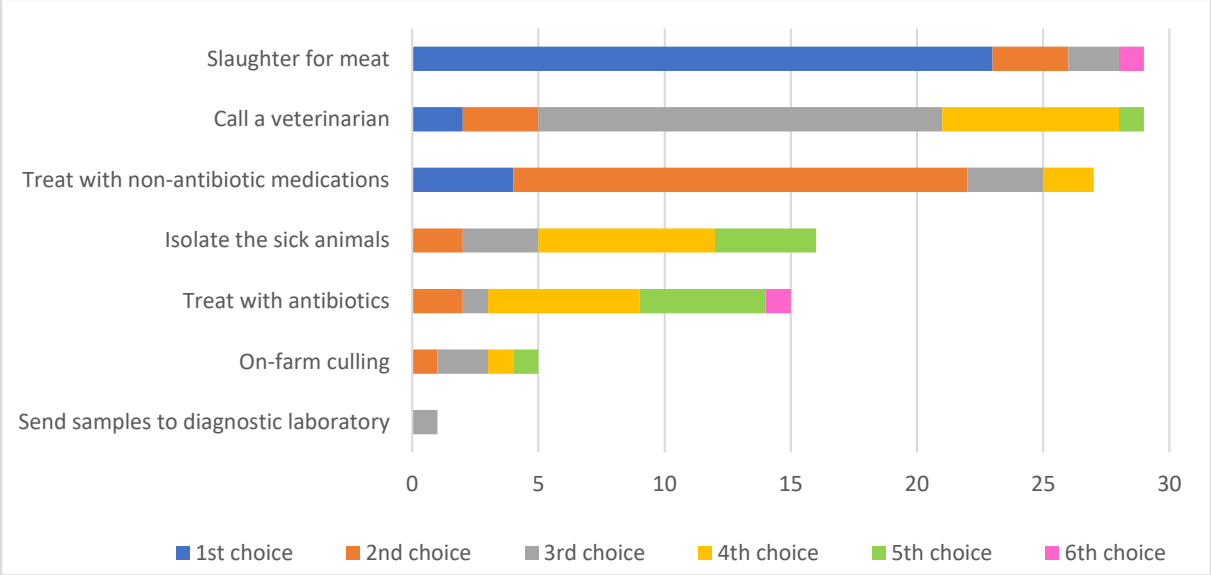
Table 23. Number of animals on the surveyed small ruminant farms (Total: 30 farmers)

	Average	Minimum	Maximum
Ewes	54.5	9	170
Rams	2.2	1	5
Lambs	31.6	4	150
Adult goats	37.3	10	160
Bucks	2.5	2	7
Kids	14.2	3	50

Source: Authors' own elaboration.

Measures in case of disease

Figure 17. Measures in case of disease on the surveyed small ruminant farms (Total: 30 farms)

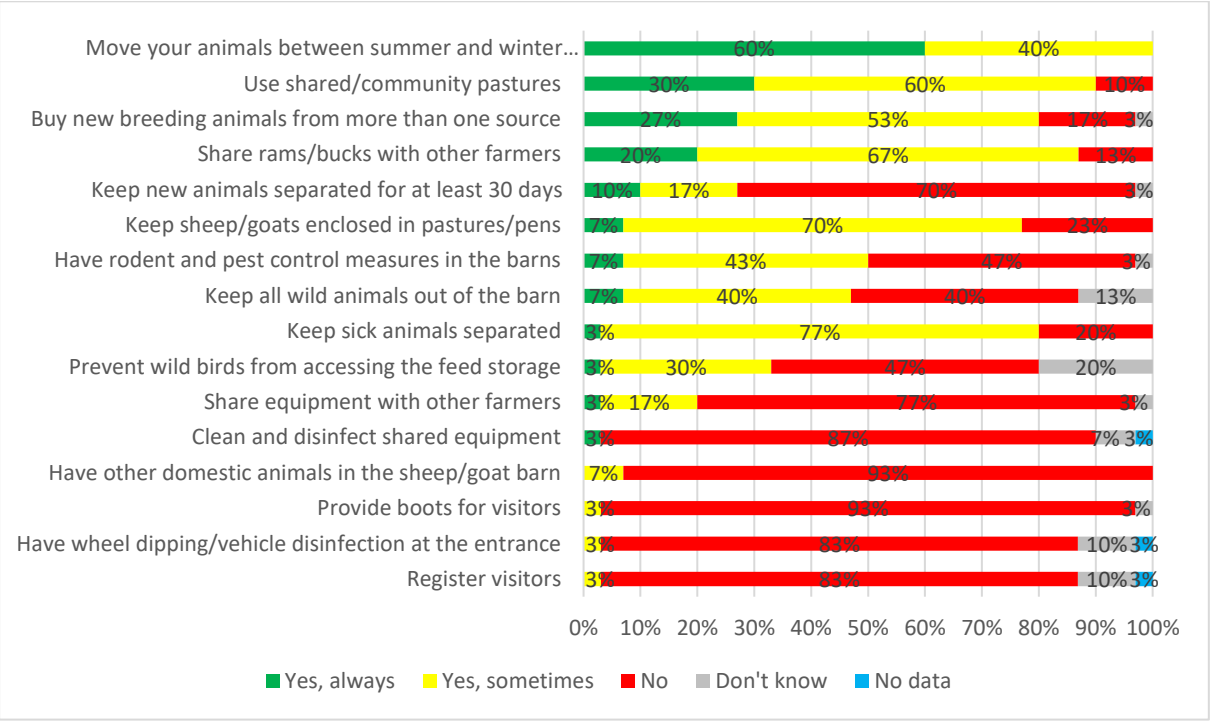


Source: Authors' own elaboration.

In case of disease, slaughtering for meat was the most common first choice measure in small ruminant farms. Treatment with non-antibiotic medications was also frequently performed, mainly as a second choice measure. Calling a veterinarian occurred mainly as a third-choice measure. Isolation of the sick animals and treatment with antibiotics were less commonly reported, and usually as a fourth or fifth choice. On-farm culling (reported by five farmers only) and sending samples to the diagnostic laboratory (reported by one farmer only) were the least common practices. One farmer did not report taking any of the listed measures.

Hygiene and biosecurity

Figure 18. Hygiene and biosecurity measures on the surveyed small ruminant farms (Total: 30 farms)



Source: Authors' own elaboration.

All farmers were moving sheep or goats between summer and winter pastures, at least sometimes. Using shared or community pastures was also common, as well as buying new breeding animals from more than one source and sharing rams or bucks with other farmers. Most farmers did not keep new animals separated, and keeping sick animals separated was not a regular measure either (77 percent did this sometimes). Having wheel dipping or vehicle disinfection, and registering and providing boots for visitors was rare.

Note: Some measures were not applicable because farmers mostly kept animals in open pastures and not in fenced areas.

Mortality due to disease (last 12 months)

The average mortalities recorded on the surveyed farms are summarized in the table below.

Table 24. Mortality on the surveyed small ruminant farms (Total: 18 of 30 farmers replied)

	Average	Range
Ewes	1.6%	0–5%
Lambs	1.4%	0–5%
Adult goats	0.3%	0–2%
Kids	0%	0%

Source: Authors' own elaboration.

Occurrence and severity of health issues or syndromes (last 12 months)

The occurrence and severity of certain health issues are presented in the table below.

Table 25. Health issues on the surveyed small ruminant farms (Total: 25 of 30 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Lambs	Breathing problems	23.3%	4.6% (0–10%)	34.3% (0–50%)
	Diarrhoea	16.7%	3.2% (2–5%)	3.0% (0–10%)
	Other intestinal problems	13.3%	11.8% (2–20%)	15.0% (0–40%)
	Sudden death	10.0%	2.0% (0–5%)	100%
	Nervous system problems	10.0%	3.3% (0–5%)	33.3% (0–50%)
	Foot rot	6.7%	5.0% (0–10%)	-
	Other	6.7%	3.0% (1–5%)	100%
	Lameness	3.3%	3.0% (3%-3%)	-
Adult ewes/ goats	Foot rot	33.3%	14.2% (2–30%)	3.3% (0–10%)
	Lameness	23.3%	11.6% (2%-25%)	0.7% (0–5%)
	Sudden death	23.3%	4.0% (1%-10%)	100%
	Other intestinal problems	20.0%	8.2% (3–20%)	23.3% (0–50%)
	Nervous system problems	13.3%	4.0% (1–5%)	50.0%
	Skin disease	3.3%	3.0%	-
	Diarrhoea	3.3%	3.0%	-
	Mastitis	3.3%	10.0%	5.0%

Source: Authors' own elaboration.

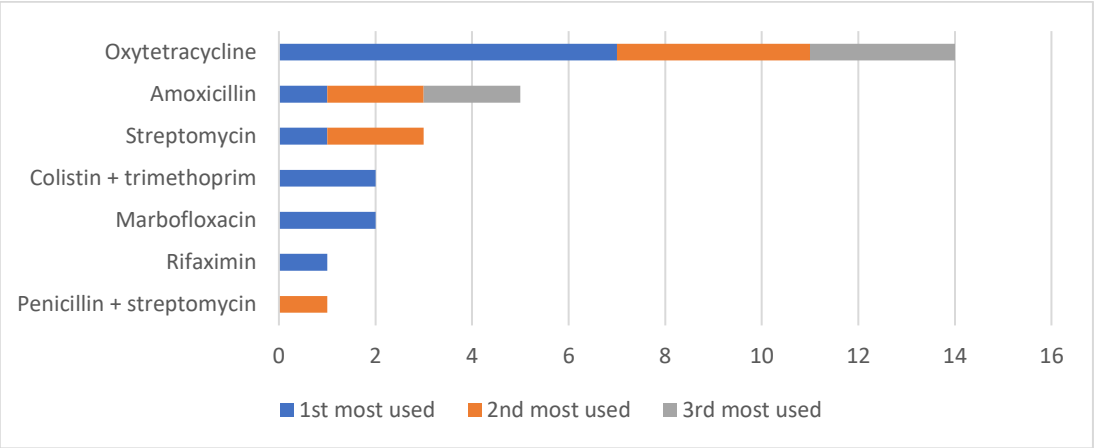
On the surveyed farms, adult ewes and goats were most frequently affected with health issues or syndromes such as lameness, foot rot, and intestinal problems. Lambs were mainly affected with breathing problems.

None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19.

Information on AMU

On the surveyed small ruminant farms, 60 percent of farmers did not use antimicrobials at all. The rest of the farmers (40 percent) reported different proportions of their animals being treated with antimicrobials. No farmer reported using antibiotics for enhancing growth or production of the animals.

Figure 19. Most used antimicrobials on the surveyed small ruminant farms (Total: 12 of 30 farmers replied)



Source: Authors' own elaboration.

The most commonly used antibiotic was oxytetracycline**.** Farmers used this medicine as treatment for diseases such as: foot rot, lameness, diarrhoea and other intestinal problems. Depending on the disease, it was applied in water or topically, for 4 to 7 days and on average to around 17 percent animals. If the treatment did not yield the expected results, 60.0 percent of farmers reported slaughtering the animal for meat (8.6 percent farmers sent for slaughter and 51.4 percent slaughtered animals for own consumption), while 40.0 percent of farmers called or consulted with a veterinarian.

Besides oxytetracycline**,** another frequently used active substance was amoxicillin. Farmers used this medicine to treat diseases such as: breathing problems, diarrhoea, and other intestinal problems. Amoxicillin was used mainly as a treatment and mostly applied as injection or in water, for 3 to 5 days. Among farmers who reported the use of this drug, most used a different antibiotic in case the treatment did not yield the expected results.

Antibiotics were given mostly to adult animals. None of the farmers reported testing samples to identify the pathogen or waiting for antimicrobial susceptibility results from the laboratory.

CHICKEN FARMS

Number of surveys: planned 20, completed 21

Note: The survey was conducted during the period of intensive field work, so the interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked but were not surveyed were not recorded. Also, there were cases when the interviewers were faced with the situation of starting a survey and after some time, given the huge number of questions, the farmers gave up and did not fully answer all the questions of the survey.

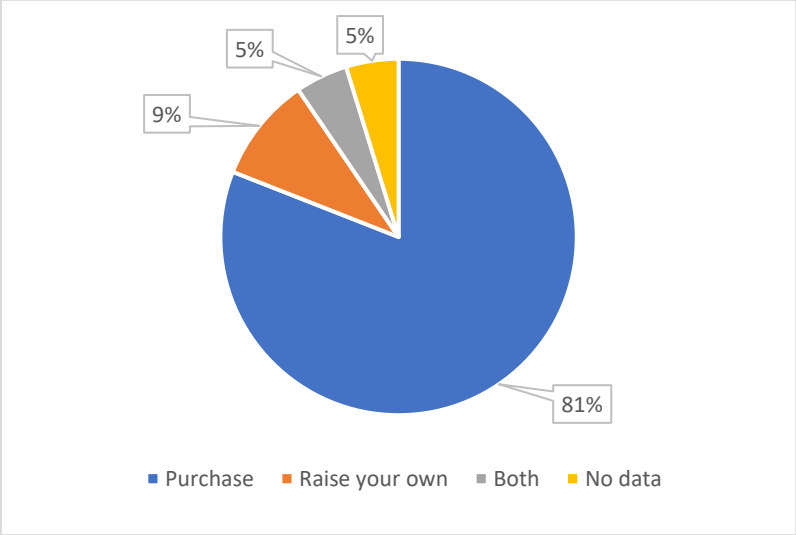
Information on farms involved in the survey

Types of chicken farms

Among the chicken farms surveyed, 57.1 percent of farmers raised chickens for meat and 42.9 percent raised them for both meat and eggs on the same farm.

Source of eggs and chickens

Figure 20. Source of eggs and chickens on the surveyed chicken farms (Total: 21 farms)



Source: Authors' own elaboration.

Regarding the source of eggs and chickens, purchasing chickens was the most common practice.

Number of animals on the surveyed farms (last 12 months)

Table 26. Number of animals on the surveyed chicken farms (Total: 20 of 21 farmers replied)

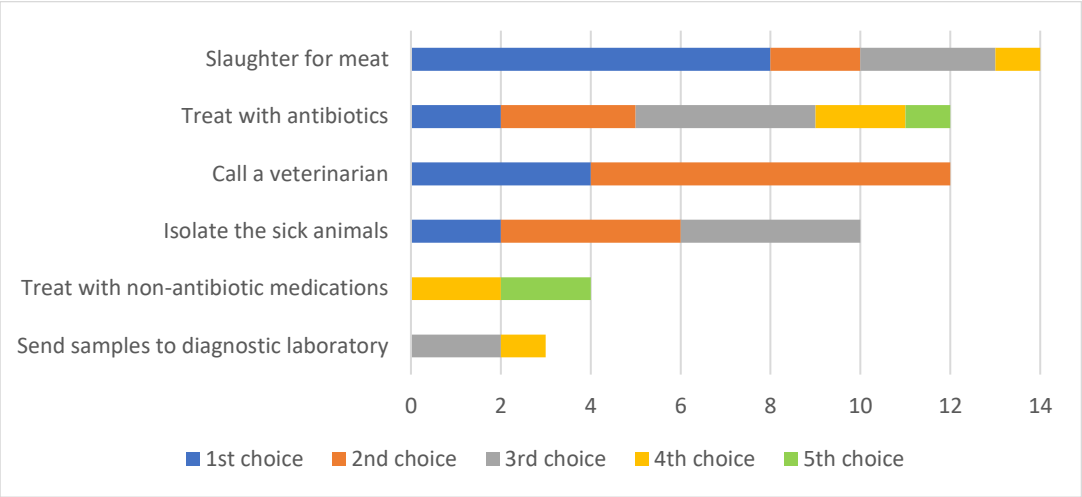
	Average	Minimum	Maximum
Chicks <1 week old	41.9	10–150	30–250
Broiler chickens	112.9	40–200	90–500
Layers	37.6	-	-

Source: Authors' own elaboration.

There was a remarkable variation in the minimum and maximum number of chickens housed on the surveyed farms in the last 12 months.

Measures in case of disease

Figure 21. Measures in case of disease on the surveyed chicken farms (Total: 21 farms)

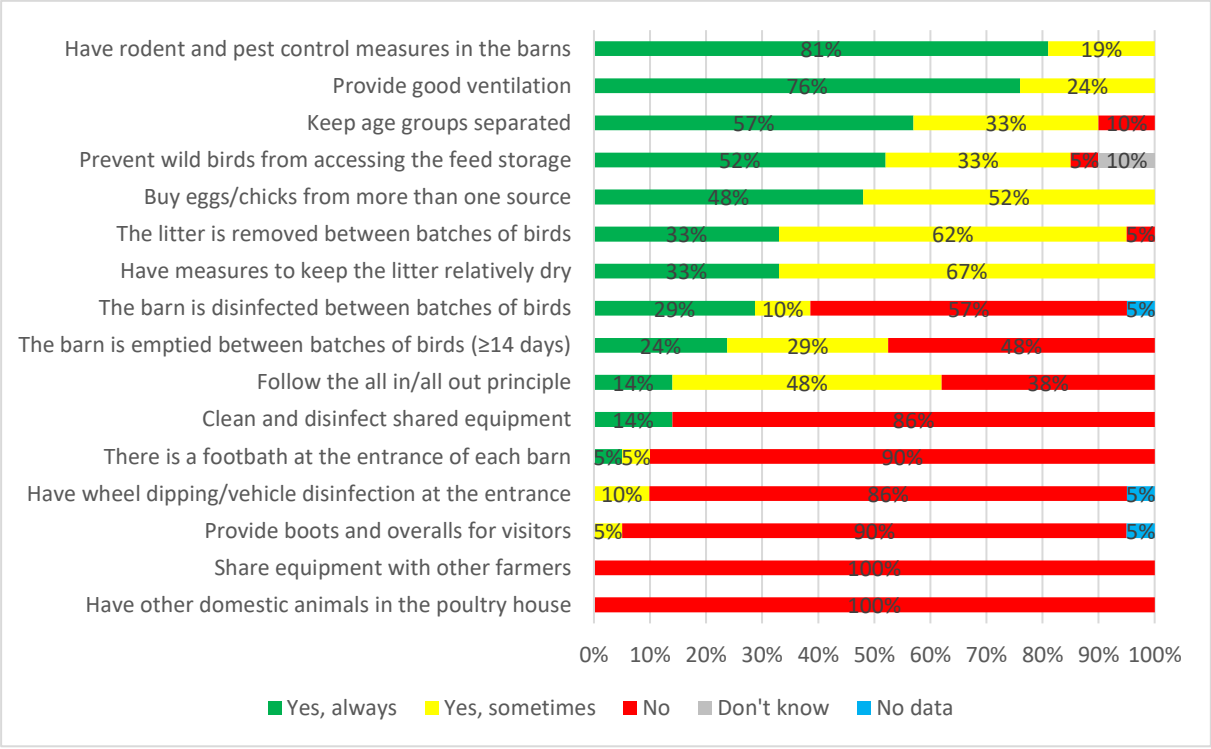


Source: Authors' own elaboration.

In case of disease, slaughtering animals for meat and treating with antibiotics were the most common practices on the surveyed chicken farms, and of these, the former was usually performed as a first choice measure. Calling a veterinarian was usually a second choice. Isolation of sick animals was mainly a third choice, performed by less farmers. Sending samples to diagnostic laboratory and treatment with non-antibiotic medications were very rarely practiced.

Hygiene and biosecurity

Figure 22. Hygiene and biosecurity measures on the surveyed chicken farms (Total: 21 farms)



Source: Authors' own elaboration.

There was no chicken farm that complied with all hygiene and biosecurity measures covered by the questionnaire. The most commonly reported good practices (i.e. followed always or sometimes by most of the farms) included having rodent and pest control measures in the barn(s) (100 percent), not having other animals in the poultry house (100 percent), providing good ventilation (100 percent), keeping age groups separated (90 percent), preventing wild birds from accessing the feed storage (85 percent), removing litter between batches of birds (95 percent) and having measures to keep litter in a relatively dry condition (100 percent). The all-in/all-out method and keeping the barn empty between flocks were practiced by around half of the farmers (62 percent and 53 percent, respectively). However, some of these practices were more likely to be applied only sometimes, as opposed to always. The rest of measures (having a footbath, wheel dipping or vehicle disinfection, and providing overalls and boots to visitors) were rarely reported.

Mortality due to disease (last 12 months)

The average mortalities recorded on the surveyed farms are summarized in the table below.

Table 27. Mortality on the surveyed chicken farms (Total: 21 farms)

	Average	Range
Chicks <1 week old	37.4%	0–100%*
Broiler chickens	33.1%	0–100%*
Layers	39.7%	0–100%*

**The highest (100%) mortality occurred in cases of nervous system diseases.*

Source: Authors' own elaboration.

In the 12 months prior to the survey, mortality due to disease was higher in layers and young chicks than in broilers, but there was no remarkable difference.

Occurrence and severity of health issues or syndromes (last 12 months)

The occurrence and severity of certain health issues are presented in the table below.

Table 28. Health issues on the surveyed chicken farms (Total: 19 of 21 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)	No. Farms
Chicks	Breathing problems	28.6%	10.0% (5–20%)	35.5% (3–50%)	6
	Nervous system problems	28.6%	5.3% (2–10%)	63.3% (30–100%)	6
	Intestinal problems	14.3%	10.0% (10–10%)	30.0% (20–50%)	3
	Skin or feather problems	14.3%	6.7% (5–10%)	25.0% (5–50%)	3
	Injuries	14.3%	5.7% (2–10%)	10.7% (2–20%)	3
	Lameness	9.5%	5.0% (5–5%)	35.0% (20–50%)	2
Broiler chickens	Lameness	47.6%	9.8% (3–20%)	20.2% (0–50%)	10
	Nervous system problems	47.6%	5.8% (1–10%)	61.1% (10–100%)	10
	Injuries	42.9%	6.9% (2–10%)	30.6% (2–100%)	9
	Breathing problems	38.1%	11.6% (3–20%)	26.0% (3–50%)	8

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)	No. Farms
	Intestinal problems	38.1%	7.9% (3–10%)	35.0% (10–50%)	8
	Skin or feather problems	19.1%	15.5% (5–40%)	8.8% (0–20%)	4
	Blindness	4.8%	1.0%	70.0%	1
Layers	Nervous system problems	23.8%	6.0% (2–10%)	60.0% (30–100%)	5
	Breathing problems	9.5%	6.0% (2–10%)	35.0% (20–50%)	2
	Intestinal problems	9.5%	10.0% (10%)	20.0% (10–30%)	2
	Skin or feather problems	9.5%	4.0% (3–5%)	12.5% (5–20%)	2
	Injuries	9.5%	6.5% (3–10%)	65.0% (50–80%)	2
	Lameness	4.8%	3.0%	30.0%	1
	Not laying	4.8%	1.0%	0%	1

Source: Authors' own elaboration.

On the surveyed farms, farmers encountered almost all the diseases listed in the survey form, but with different prevalence. They did not report problems with blindness in the chicks or layers category. Nervous system problems were common in all categories. Besides that, breathing problems in chicks and lameness in broiler chickens were the main issues.

None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19

Note: Almost all farmers (90.9 percent) replied to this question about broilers, while less provided information about chicks (52.4 percent) and layers (34.8 percent).

Vaccination

No farmers reported vaccinating their chicks, broilers or layers.

Information on AMU

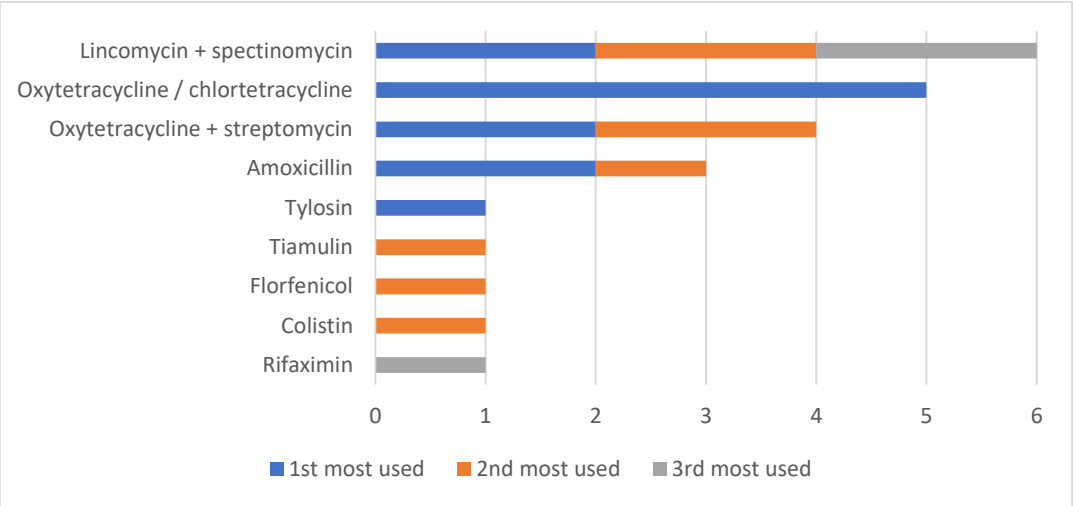
Around half of farmers (57.1 percent) treated their chickens with antimicrobials at least once during their lives, while 19.1 percent did not use antimicrobials at all. The rest of the farmers (23.8 percent) did not answer the question.

Of those farmers who reported using antibiotics, 8.3 percent used only one antibiotic, while 66.7 percent used two different antibiotics and 25 percent of farmers used three.

None of the farmers used antibiotics for enhancing growth or egg production of chickens.

The most used antimicrobials were as follows:

Figure 23. Most used antimicrobials on the surveyed chicken farms (Total: 12 of 21 farmers replied)



Source: Authors' own elaboration.

The most commonly used drugs (lincomycin with spectinomycin and oxytetracycline) were applied against breathing problems. Antibiotics were given only as treatment (not for prevention) and were given in water for 5 days in accordance with the advice of the veterinarian. The combination of oxytetracycline and streptomycin was also used in water, but against intestinal problems.

If the treatment with the first antimicrobial did not yield the expected results:

- four of 12 farmers (33.3 percent) reported consulting with a veterinarian
- three farmers (25.0 percent) reported using a different antibiotic
- one farmer (8.3 percent) reported repeating the treatment with the same antibiotic
- one farmer (8.3 percent) reported killing and discarding the animal
- one farmer (8.3 percent) reported sending for slaughter
- one farmer (8.3 percent) reported slaughtering for their own consumption
- one farmer (8.3 percent) reported doing nothing

None of the farmers reported testing samples to identify the pathogen or waiting for antimicrobial susceptibility results from the laboratory.

PIG FARMS

Number of surveys: planned 20, completed 23

Note: Two farmers refused to answer one question (Q6) due to too many sub-questions.

Information on farms involved in the survey

Number of animals on the surveyed farms (last 12 months)

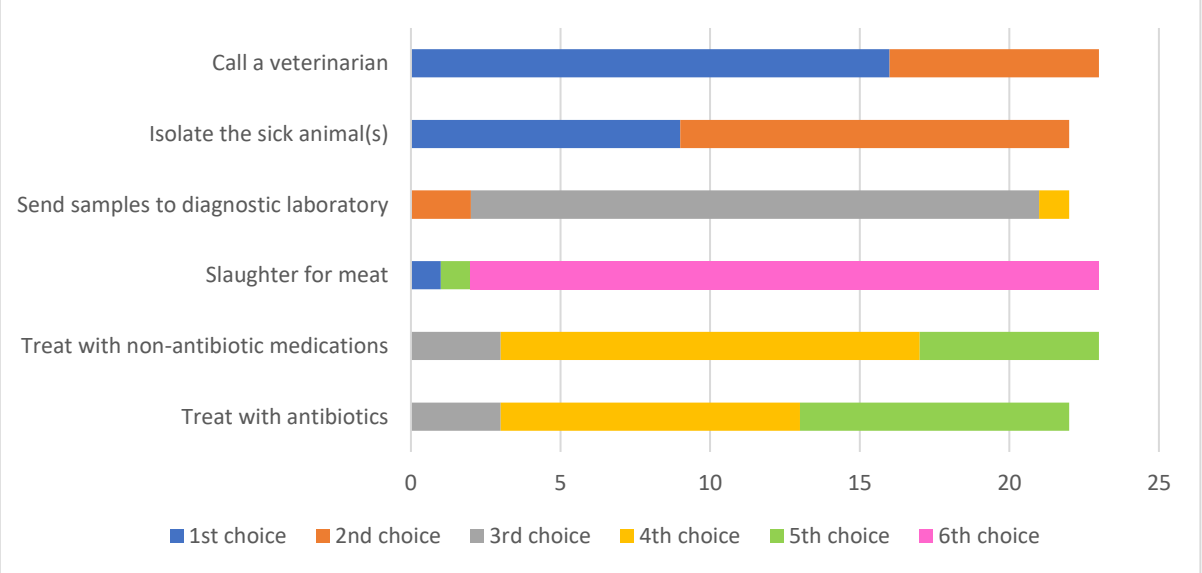
Table 29. Number of animals on the surveyed pig farms (Total: 23 farms)

	Average	Minimum	Maximum
Sows	29.7	5–38	5–47
Boar	1.2	1–2	1–2
Piglets (suckling the sow)	89.4	10–59	60–234
Fattening pigs	41.6	6–34	12–126

Source: Authors' own elaboration.

Measures in case of disease

Figure 24. Measures in case of disease on the surveyed pig farms (Total: 23 farms)

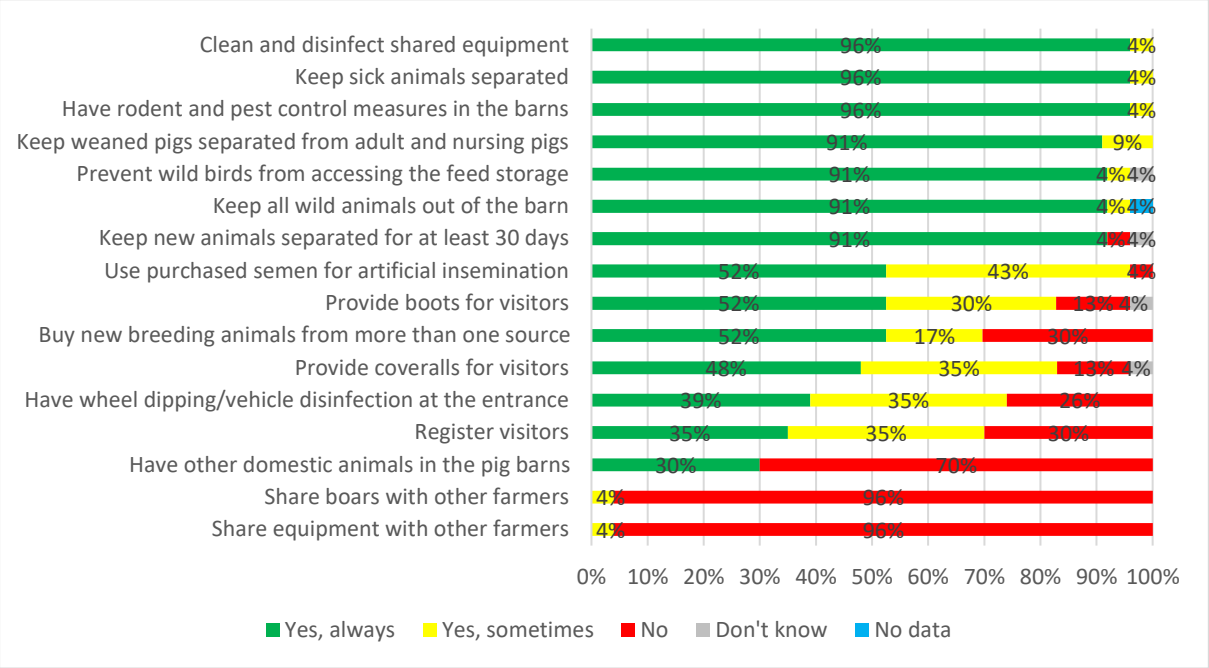


Source: Authors' own elaboration.

In case of disease, calling a veterinarian was the most common first choice measure in pig farms. Isolation of sick animals was also frequently performed in almost the same number as calling a veterinarian. Sending samples to a diagnostic laboratory was most often a third choice. Treatment with non-antibiotics was more common than treatment with antibiotics. Slaughtering for meat was usually a last choice option for farmers.

Hygiene and biosecurity

Figure 25. Hygiene and biosecurity measures on the surveyed pig farms (Total: 23 farms)



Source: Authors' own elaboration.

No farm complied with all hygiene and biosecurity principles included in the questionnaire, although around 30 percent of farms were very close to complying with all measures. The most commonly applied measures were: keeping sick animals separated, having a rodent and pest control program in the barn(s), keeping weaned pigs separated from adult and nursing pigs, preventing wild animals from accessing the barns or the feed storage, and keeping new animals separated when introducing to the farm. These measures were always performed by 91–96 percent of farmers. In addition, most farmers never shared boars or equipment with other farmers.

Many farmers provided boots and coveralls for visitors, registered them and had wheel dipping or vehicle disinfection at the entrance of the farm, but these areas could be strengthened on some of the farms.

Mortality due to disease (last 12 months)

The average mortalities recorded on the surveyed farms are summarized in the table below.

Table 30. Mortality on the surveyed pig farms (Total: 20 of 23 farmers replied)

	Average	Range
Piglets	7.9%	1–25%
Fattening Pigs	8.2%	2–100%
Adult sows and boars	3.7%	2–5%

Source: Authors' own elaboration.

In the last 12 months, average mortality due to disease was highest among fattening pigs and lowest among adult sows and boars.

Note: 87.0 percent of farmers answered this question.

Occurrence and severity of health issues or syndromes (last 12 months)

Occurrence and severity of certain health issues are presented in the table below.

Table 31. Health issues on the surveyed pig farms (Total: 21 of 23 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Piglets (suckling the sow)	Breathing problems	81.0%	32.9% (10–60%)	7.7% (2–20%)
	Diarrhoea	57.1%	29.6% (5–50%)	11.5% (3–25%)
	Swine dysentery	19.1%	25.0% (15–30%)	5.0%
	Sudden death	14.3%	3.7% (1–5%)	3.7% (1–5%)
	Skin problems	9.5%	12.5% (5–20%)	10.0% (10–10%)
	Nervous system problems	4.8%	5.0%	5.0%
	Porcine Reproductive and Respiratory Syndrome (PRRS)	4.8%	20.0%	3.0%
	Other intestinal problems	4.8%	25.0% (25–25%)	5.0% (5–5%)
Fattening Pigs	Breathing problems	61.9%	20.0% (10–30%)	3.6% (2–5%)
	Diarrhoea	38.1%	20.0% (5–40%)	4.6% (2–10%)
	Swine dysentery	19.1%	15.0% (10–25%)	4.0% (3–5%)
	Skin problems	19.1%	11.3% (5–20%)	-
	Sudden death	9.5%	7.5% (5–10%)	52.5% (5–100%)
	Porcine Reproductive and Respiratory Syndrome (PRRS)	4.8%	20.0%	3.0% (3–3%)
Adult sows and boars	Breathing problems	52.4%	17.7% (10–30%)	3.8%
	Diarrhoea	19.1%	15.0% (5–40%)	3.5% (2–5%)
	Swine dysentery	14.3%	16.7% (10–25%)	2.0%
	Sudden death	14.3%	4.7% (4–5%)	4.7% (4–5%)
	Porcine Reproductive and Respiratory Syndrome (PRRS)	9.5%	17.5% (15–20%)	3.0%
	Skin disease	4.8%	5.0%	-

Source: Authors' own elaboration.

On the surveyed farms, piglets were most frequently affected with health issues or syndromes. Breathing problems and diarrhoea were the most common issues in all groups. None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19.

Note: 91.3 percent of farmers answered this question.

Vaccination

Vaccination was not common on the surveyed pig farms with only 26.1 percent reporting this practice. On these farms, vaccination was used against breathing problems and diarrhoea.

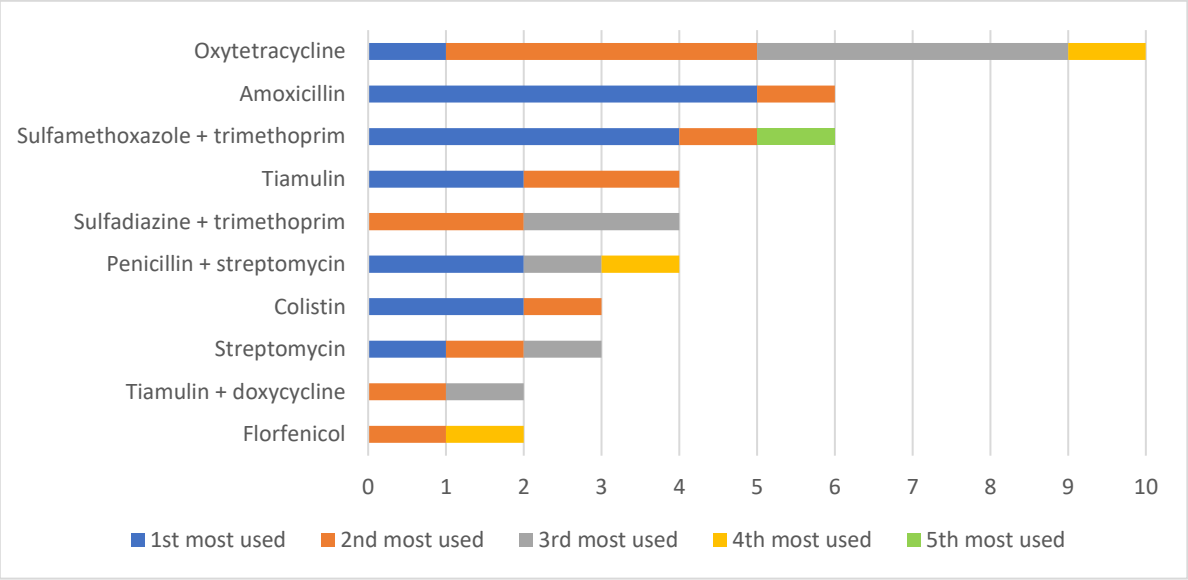
Information on AMU

On the surveyed pig farms, 26.1 percent of farmers did not use antimicrobials at all, while the rest (73.9 percent) reported different proportions of their animals being treated with antimicrobials. Only one farmer (4.3 percent) reported using antimicrobials for growth promotion in fattening pigs.

Among the 73.9 percent of farmers who used antibiotics, most of them reported using two (29.4 percent) or three (35.3 percent) different substances. Using only one (17.7 percent), or more than three different drugs (17.7 percent) were less common.

The most frequently used antimicrobials were the following:

Figure 26. Most used antimicrobials on the surveyed pig farms (17 of 23 farmers replied)



Source: Authors' own elaboration.

Note: The substance that was used for growth promotion is not included on the chart, because the farmer did not know the name of the antibiotic, as it was administered by the veterinarian.

Treatment of breathing problems in piglets was the most common reason for the use of antibiotics (41.9 percent). Tiamulin, amoxicillin, the combination of penicillin and streptomycin, colistin, oxytetracycline, and the combination of tiamulin and doxycycline were all administered against this health issue. On most farms, all animals were treated at least once over the previous 12 months against this problem.

Diarrhoea in piglets was the second most common cause for antibiotic use (11.6 percent). Sulfamethoxazole combined with trimethoprim, colistin, sulfadiazine with trimethoprim and penicillin with streptomycin were administered to cure this disease.

In most cases veterinarians administered medicines as almost all farmers avoided doing it themselves. Medicines were usually administered in water for 5 days.

If treatment with these antibiotics did not yield the expected results, all farmers who completed this section of the survey reported consulting with a veterinarian.

None of the farmers reported testing samples to identify the pathogen or waiting for antimicrobial susceptibility results from the laboratory.

BEE FARMS

Number of surveys: planned 40, completed 46

Note: No farmers refused to answer any of the questions.

Information on farms and farmers involved in the survey

Purpose of beekeeping

On the surveyed bee farms in this country, every farmer kept bees for honey. Keeping bees for honey only was the most common practice (23.9 percent of farms). Keeping them for honey, pollen and propolis (15.2 percent), for honey, royal jelly, pollen and propolis (15.2 percent), for honey, royal jelly and propolis (13.0 percent) or honey in combination with other product (e.g. pollination, royal jelly, wax, pollen, propolis, queen bees and swarm; in total 32.6 percent) was less common.

Origin of bees

The majority (91.3 percent) of the surveyed farmers raised their own bees and 6.5 percent of farmers raised their own and purchased at the same time while only 2.2 percent had only purchased bees. Bees were bought from friends in the immediate area.

Moving bees to different locations

On the surveyed farms, moving of bees occurred at the following frequency:

- 80.4 percent did not move bees;
- 10.9 percent moved bees once a year; and
- 8.7 percent moved bees twice a year.

Number of hives on the surveyed farms (last 12 months)

Table 32. Number of animals on the surveyed bee farms (Total: 46 farms)

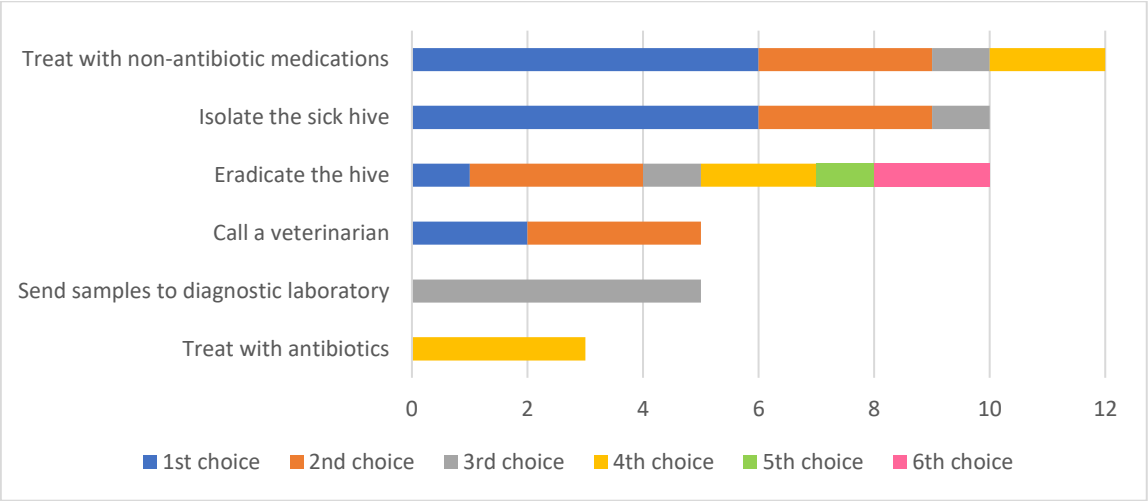
	Minimum	Maximum	Average
Nucleus hives (Beginner hives or swarms)	0–24	1–40	9.97
Production hives (Colonies)	0–69	2–78	7.54

Source: Authors' own elaboration.

There was a high variation in the minimum and maximum number of beehives housed on the surveyed farms in the last 12 months.

Measures in case of disease

Figure 27. Measures in case of disease on the surveyed bee farms (Total: 46 farms)



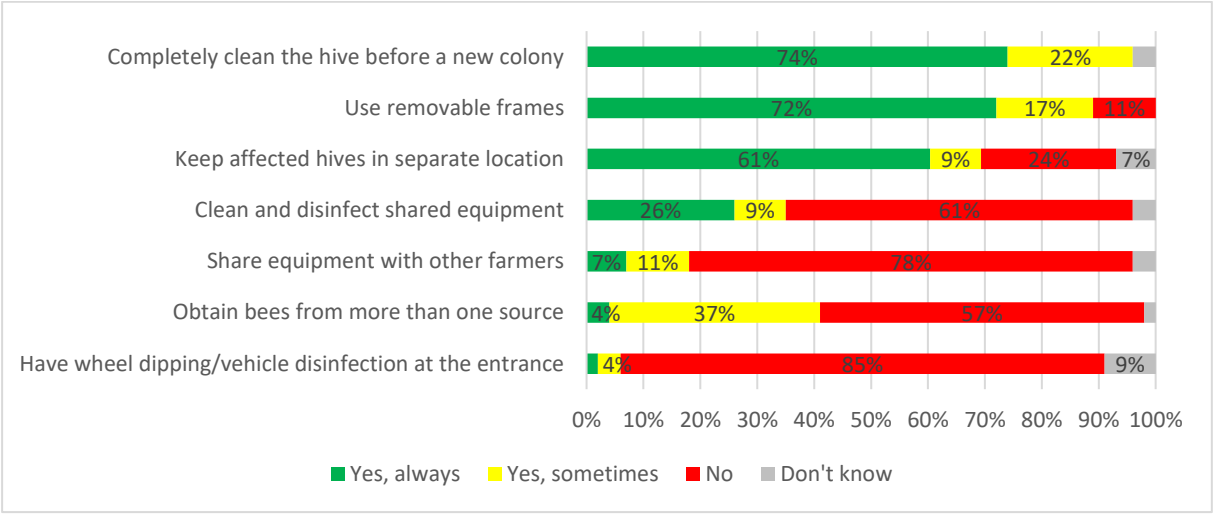
Source: Authors' own elaboration.

An equal number of farmers chose isolation of the sick hive and treatment with non-antibiotic medications as the first and second choice measures in case of disease. Calling a veterinarian was mentioned also as first or second choice, but by a lower number of farmers. Destruction of the beehive was listed by many farmers, but only as a third to sixth choice in many cases. Sending samples to the diagnostic laboratory and treatment with antibiotics were the least common choices.

Note: Some farmers gave the same rating for different interventions (e.g., both isolation and treatment with non-antibiotic medications could be marked as a first choice).

Hygiene and biosecurity

Figure 28. Hygiene and biosecurity measures on the surveyed bee farms (Total: 46 farms)



Source: Authors' own elaboration.

On the surveyed bee farms, completely cleaning the hive before introducing a new colony or swarm was always done by most (73.9 percent) farmers, while 21.7 percent sometimes performed

complete cleaning and sometimes did not. The majority of farmers (78.3 percent) did not share equipment with other farmers. Only 4.4 percent of farmers reported always obtaining bees from more than one source. Keeping affected hives in separate locations (quarantine apiary) for at least 30 days was practiced by 60.9 percent of farmers and 71.7 percent of farmers used removable frames. Using vehicle disinfection was rarely done.

Occurrence and severity of health issues or syndromes (last 12 months)

Occurrence and severity of certain health issues are presented in the table below.

Table 33. Health issues on the surveyed bee farms (Total: 7 of 46 farmers replied)

	Health issue	Ratio of farms affected	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Nucleus hives	Unknown disease	4.4%	15.0% (10–20%)	100%
	Varroa infection	2.2%	10.0%	100%
Production hives	Varroa infection	6.5%	16.7% (15–20%)	10.7% (7–15%)
	Breathing problems	2.2%	10.0% (10–10%)	100%

Source: Authors' own elaboration.

Production hives were slightly more affected with health issues than nucleus hives on the surveyed farms. The most common problems included Varroa infection and breathing problems in production hives. Farmers did not experience an increase in the occurrence of health issues due to problems related to COVID-19.

Note: Only 15.2 percent of farmers answered this question.

Information on AMU

The farmers stated that they avoided treating the bees with antibiotics so they did not list any drugs in this section.

BACKYARD FARMS

Number of surveys: planned 200, completed 208

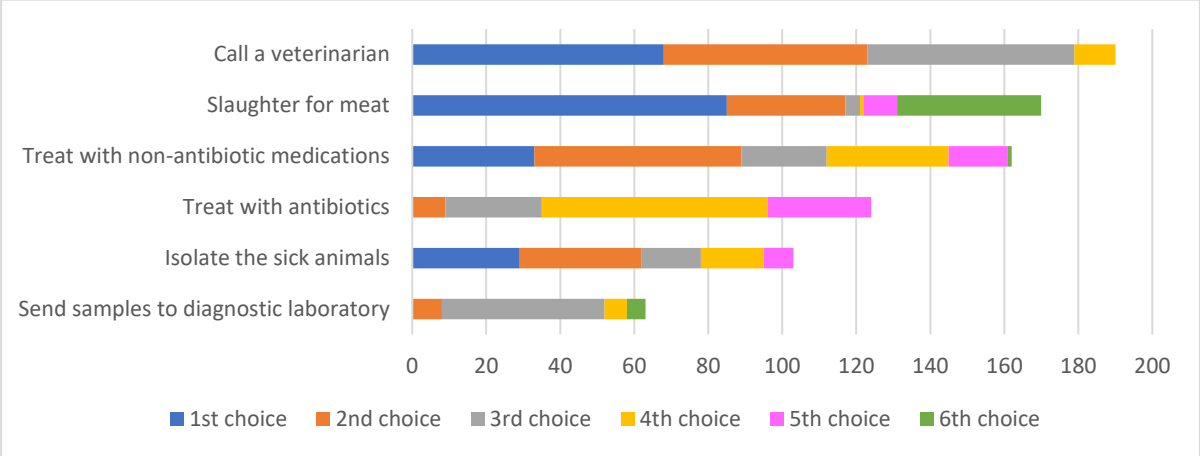
Note: The survey was conducted during the period of intensive field work, so the interviewers encountered situations where farmers did not have time to answer the surveys. Farmers who were asked but were not surveyed were not recorded. Also, there were cases when the interviewers were faced with the situation of starting a survey and after some time, given the huge number of questions, the farmers gave up and did not fully answer all the questions of the survey. In case of backyard farms, 14 farmers could not list the most used antibiotics, as the veterinarians were in charge of administering drugs on their farms.

Information on farms and farmers involved in the survey

The surveyed backyard farmers mainly housed cattle, sheep and chickens. Pigs were found on backyard farms in the Republic of Srpska entity only. The number of animals per farm was different but many backyards had animals for their own needs.

Measures in case of disease

Figure 29. Measures in case of disease on the surveyed backyard farms (Total: 206 of 208 farmers replied)

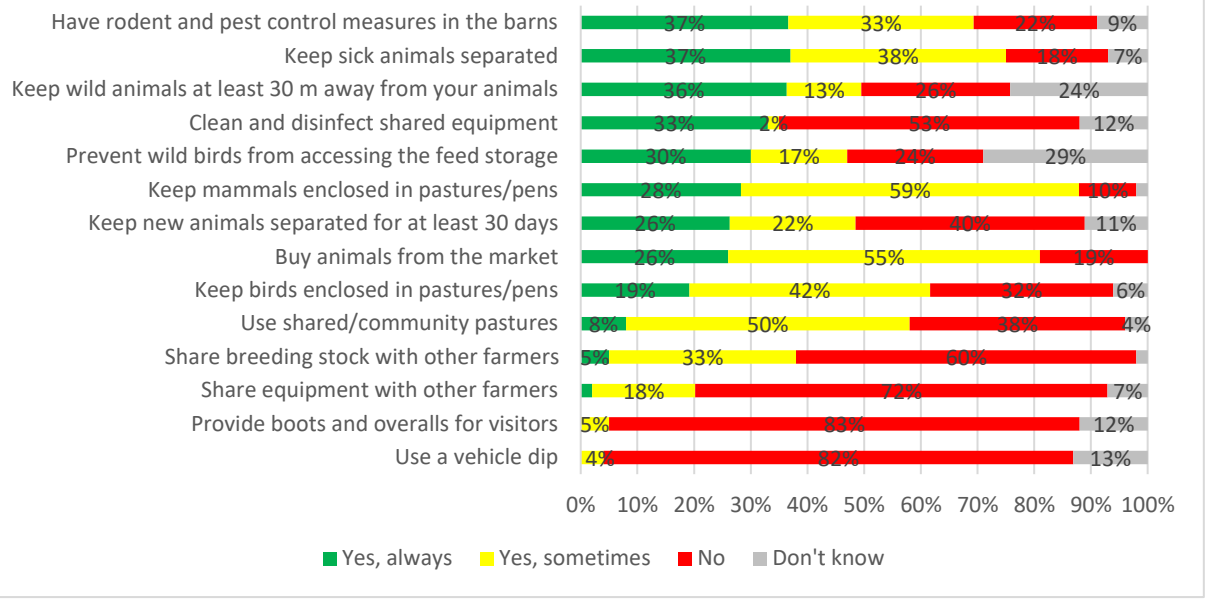


Source: Authors' own elaboration.

In case of disease, the most common measures were slaughter for meat and calling a veterinarian. Farmers preferred non-antibiotic treatment over antibiotic treatment and antibiotic treatment was never reported as the first choice. Isolation of sick animals was cited by approximately half of farmers. Sending samples to diagnostic laboratory was mainly a third choice, done by around one third of the surveyed farmers.

Hygiene and biosecurity

Figure 30. Hygiene and biosecurity measures on the surveyed backyard farms (Total: 208 farms)



Source: Authors' own elaboration.

Having rodent and pest control measures in the barn(s) (70 percent), keeping sick animals separated (75 percent), and keeping animals enclosed (87 percent) were practiced by the highest number of backyard farmers, but in many cases, these were done only sometimes, as opposed to always. Around half of farmers kept wild animals away, prevented wild birds from accessing the feed storage and kept new animals separated. Most farmers did not share equipment or breeding stock with other farmers, however, using shared or community pastures was common. Having wheel or vehicle disinfection at the farms' entrance and giving protective clothes to visitors were rare.

Mortality due to disease (last 12 months)

Table 34. Mortality on the surveyed backyard farms (Total: 36 of 208 replied)

Species	Age	Ratio of farms reporting mortality*	Average	Range
Broiler chickens	Young	2.4%	4.4%	1–10%
	Adult	0.5%	10.0%	-
Layer chickens	Young	2.4%	3.6%	1–10%
	Adult	6.3%	6.6%	0–28%
Dairy cattle	Young	-	-	-
	Adult	1.4%	17.3%	0–50%
Sheep	Young	1.4%	1.3%	1–2%
	Adult	2.9%	6.8%	1–10%
Goats	Young	-	-	-
	Adult	0.5%	50.0%	-
Pigs	Young	-	-	-
	Adult	2.4%	26.0%	0–50%

Species	Age	Ratio of farms reporting mortality*	Average	Range
Bees (beehives)	Young	0.5%	25.0%	25–25%
	Adult	1.4%	20.7%	7–30%

**Among farms housing that specific animal species.*

Source: Authors' own elaboration.

Average mortality due to disease varied among different animal species and age groups.

Note: Only 17.3 percent of farmers answered this question.

Occurrence and severity of health issues or syndromes (last 12 months)

Table 35. Health issues on the surveyed backyard farms (Total: 192 of 208 farmers replied)

Species	Health issue	Age	Ratio of farms affected*	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
Dairy cattle	Mastitis	Adult	5.5%	76.0% (50–100%)	-
	Other (snake bite)	Adult	1.1%	50.0% (1 farm)	100% (1 farm)
Layer chickens	Breathing problems	Adult	1.3%	1.0% (1 farm)	1.0% (1 farm)
	Injuries	Young	1.3%	5.0% (1 farm)	50.0% (1 farm)
		Adult	11.7%	5.3% (1–10%)	44.3% (2–100%)
	Intestinal problems	Young	1.3%	50.0% (1 farm)	-
	Lameness	Adult	1.3%	10.0% (1 farm)	10.0% (1 farm)
	Not laying	Adult	2.6%	7.5% (5–10%)	-
	Other (sudden death)	Young	1.3%	10.0% (1 farm)	10.0% (1 farm)
	Skin or feather problems	Young	1.3%	10.0% (1 farm)	3.0% (1 farm)
		Adult	2.6%	6.0% (1 farm)	2.0% (1 farm)
Broiler chickens	Breathing problems	Young	7.7%	10.0% (1 farm)	3.0% (1 farm)
	Lameness	Young	7.7%	10.0% (1 farm)	10.0% (1 farm)
	Skin or feather problems	Young	7.7%	10.0% (1 farm)	10.0% (1 farm)
Goats	Other (snake bite)	Adult	8.3%	50.0% (1 farm)	100% (1 farm)
Pigs	Breathing problems	Adult	2.6%	25.0% (1 farm)	-
	Injuries	Adult	5.3%	62.5% (25–100%)	25.0%
	Other (fever)	Adult	5.3%	25.0% (1 farm)	25.0% (1 farm)
Sheep	Intestinal problems	Adult	2.8%	10.0% (1 farm)	-
	Lameness	Adult	11.1%	7.1% (10–20%)	-
	Mastitis	Adult	2.8%	-	1.0% (1 farm)

	Health issue	Age	Ratio of farms affected*	Average ratio of animals affected (incl. ranges)	Average mortality ratio (incl. ranges)
	Nervous system problems	Young	2.8%	10.0% (1 farm)	40.0% (1 farm)
		Adult	2.8%	2.0% (1 farm)	50.0% (1 farm)
	Other (sudden death)	Young	2.8%	1.0% (1 farm)	1.0% (1 farm)
		Adult	2.8%	5.0% (1 farm)	100% (1 farm)
	Reproductive problems	Adult	2.8%	5.0% (1 farm)	50.0% (1 farm)
Turkeys	Blindness	Adult	25.0%	10.0% (1 farm)	50.0% (1 farm)

**Among farms housing that specific animal species.*

Source: Authors' own elaboration.

The occurrence and severity of diseases varied among different animal species and age groups. None of the farmers experienced an increase in the occurrence of any health issues due to problems related to COVID-19.

Vaccination

Vaccination was not common on the surveyed backyard farms: only five farmers vaccinated their animals (usually dairy cattle).

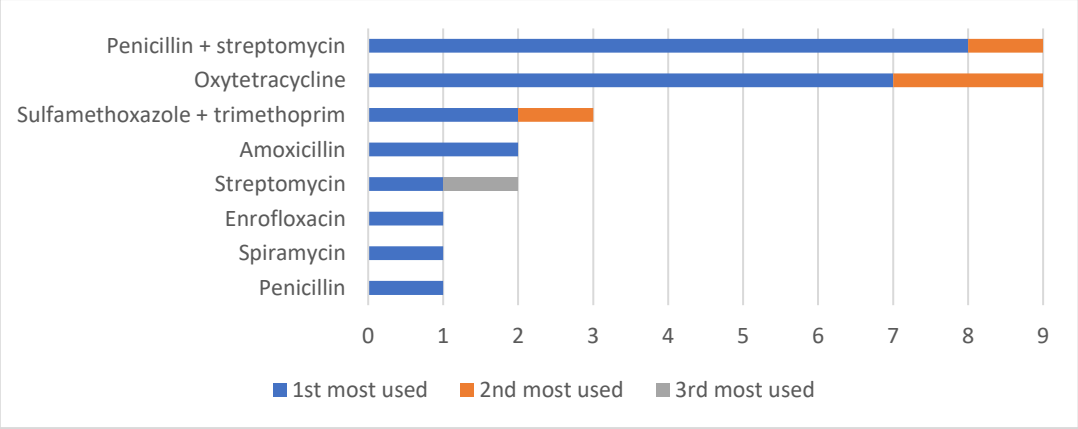
Information on AMU

Of those farmers surveyed on backyard farms, 80.8 percent declared that they do not use antibiotics, while 19.2 percent reported different proportions of their animals being treated with antimicrobials.

From the antibiotic user farmers (19.2 percent), most of them (47.5 percent and 10.0 percent) used one or two different substances, respectively and using three substances was less common (2.5 percent). Many farmers reported that they used antibiotics but did not know their names (40.0 percent) because veterinarians were in charge of administering antibiotics on their farms. None of the farmers reported using antibiotics for enhancing growth or production of animals.

The most used antimicrobials are summarised in the figure below.

Figure 31. Most used antimicrobials on the surveyed backyard farms (Total: 23 of 208 farmers replied)

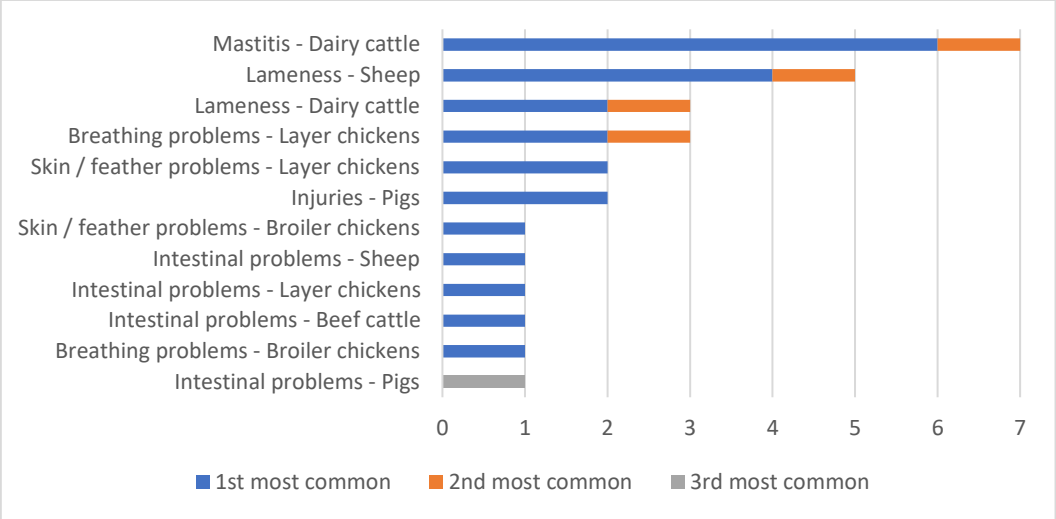


Source: Authors' own elaboration.

The most used antibiotics on the surveyed backyard farms were the combination of penicillin and streptomycin, oxytetracycline, and trimethoprim combined with sulfamethoxazole.

The main indications for antibiotic use were mastitis in dairy cattle and lameness in sheep. Intestinal and breathing problems in various species were also treated with these drugs. A summary of diseases against which the first to fifth most used antibiotics were applied can be seen in the following chart.

Figure 32. Most common indications of AMU on the surveyed backyard farms (Total: 23 of 208 farmers replied)



Source: Authors' own elaboration.

The administration of antibiotics to adult animals was more common (up to 83.3 percent of cases) than medicating young animals on the surveyed backyard farms. Drugs were mainly given as treatment (96 percent), while preventive use was seldom (4 percent) reported. They were administered as injections (46 percent), orally (including drench, medicated feed, and medicated drinking water) (37.5 percent) or topically (17.0 percent). In most cases, antibiotics were administered for five consecutive days, and an average of 45–55 percent of animals had to be treated with them per year. If the treatment with the chosen drug did not yield the expected results, farmers usually (in 91.0 percent of cases) consulted with a veterinarian. None of the farmers reported testing samples to identify the pathogen or waiting for antimicrobial susceptibility results from the laboratory.

VETERINARIAN SURVEYS

GENERAL DATA OF SURVEYS

Total number of surveys: 100

Note: 29 percent of veterinarians refused to answer the questions about most frequently diagnosed and treated diseases, as those were too long.

Date of surveys

- First survey: 1 July 2022
- Last survey: 2 August 2022

Distribution of surveys (Entity)

- Republic of Srpska 46 (46.0 percent)
- Federation of BiH 54 (54.0 percent)

INFORMATION ON VETERINARIANS INVOLVED IN THE SURVEY

Role and education of veterinarians

Among the surveyed veterinarians:

- 13.0 percent were the owner or co-owner of the veterinary practice;
- 34.0 percent were the manager of the veterinary practice; and
- 99.0 percent were employees.

Note: More than one answer could be provided.

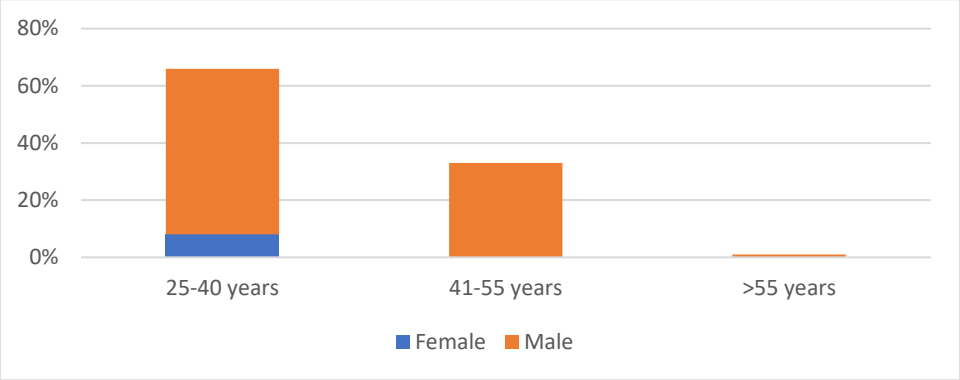
All participants completed higher education or a master degree to become veterinarians. All of them reported having antibiotic resistance included in their education.

Number of years veterinarians practiced veterinary medicine

- Median: 10 years
- Range: 3–30 years

Age and gender of veterinarians

Figure 33. Age and gender distribution of veterinarians participating in the survey (Total: 100 veterinarians)



Source: Authors' own elaboration.

The veterinarians surveyed were often between 25–40 years old (58.0 percent) and overwhelmingly males (92.0 percent). All surveyed female veterinarians (eight) were also between 25–40 years old and had from three to ten years of experience. All veterinarians focused on pets and one was working with cattle. All eight were employees and only one had income from other sources.

Income of veterinarians

Only one male and one female veterinarian had income from sources other than their veterinary practice.

Practice record availability

Almost all veterinarians (more than 90 percent) kept records about farms in their practice, and the antibiotics sold or prescribed by them (see details in Annex 5).

Number and type of farms in veterinary practices

Table 36. Number and type of farms visited by the surveyed veterinarians (Total: 100 veterinarians)

Species	Ratio of veterinarians working with this species	Number of farms in practice per veterinarian		Type of farms in practice
		Average	Range	
Other (dogs, cats)	93.0%	NA	NA	NA
Beef cattle	62.0%	100	1–200	21% of veterinarians worked only with backyard beef farms. 40% worked with backyard and semi-commercial and 1% with all three types of farms.
Dairy cattle	62.0%	50	3–600	20% of veterinarians worked only with backyard dairy farms. 41% worked with backyard and semi-commercial and 1% with all three types of farms.

Species	Ratio of veterinarians working with this species	Number of farms in practice per veterinarian		Type of farms in practice
		Average	Range	
Sheep	61.0%	50	3–500	21% of veterinarians worked only with backyard sheep farms. 39% worked with backyard and semi-commercial and 1% with all three types of farms.
Goats	60.0%	25	1–100	21% of veterinarians worked only with backyard goat farms. 39% worked with backyard and semi-commercial farms.
Bees (beehives)	57.0%	52	10–200	48% of veterinarians worked with backyard bee farms only, while 9% worked with backyard and semi-commercial farms.
Broiler chickens	54.0%	23	2–100	26% of veterinarians worked only with backyard broiler chicken farms. 27% worked with backyard and semi-commercial and 1% only with semi-commercial broiler chicken farms.
Layer chickens	51.0%	40	1–200	25% of veterinarians worked only with backyard layer chicken farms, while 26% worked with both backyard and semi-commercial layer chicken farms.
Pigs	43.0%	50	3–200	20% of veterinarians worked only with backyard pig farms. 22% worked with backyard and semi-commercial and 1% with all three types of farms.
Rabbits	36.0%	No data	No data	36% of veterinarians worked only with backyard rabbit farms.
Geese	28.0%	No data	No data	28% of veterinarians worked only with backyard geese farms.
Ducks	28.0%	No data	No data	28% of veterinarians worked only with backyard duck farms.
Turkeys	28.0%	8	2–20	28% of veterinarians worked only with backyard turkey farms.
Horses for meat	23.0%	No data	No data	23% of veterinarians worked only with backyard horses for meat farms.

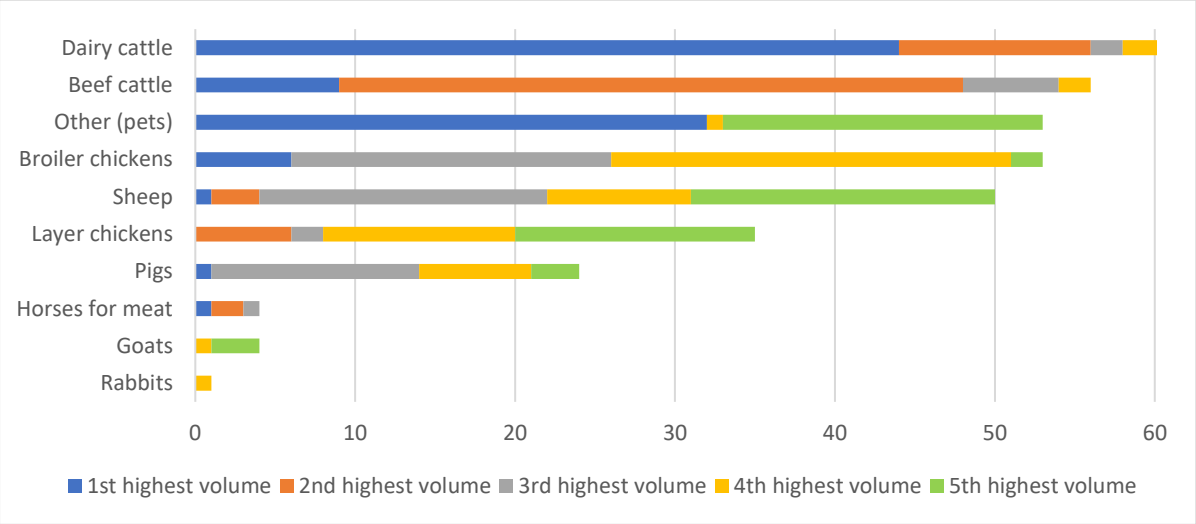
Source: Authors' own elaboration.

The majority of the surveyed veterinarians worked with ruminants, bees and chickens in their practice, in addition to working with pets. A single professional treating several different species was very common in BiH: the average number of different species was 6.9 in their practice, with 14 being the maximum and only 36.0 percent of veterinarians worked with only one species. (*Note: In this context, dairy and beef cattle were counted separately*). Among the different farm types, visiting backyard farms was the most common, and large commercial farms were least frequently involved in the veterinarians' practice.

INFORMATION ON AMU

Antibiotic prescription per animal species

Figure 34. Rank of species by the volume of antibiotics prescribed by the surveyed veterinarians (Total: 95 of 100 veterinarians replied)



Source: Authors' own elaboration.

Veterinarians prescribed the highest amount of antibiotics for dairy cattle, beef cattle and pets. The third ranking species were broiler chickens and sheep, followed by layer chickens and pigs. Most antibiotics were prescribed for animals kept on backyard and semi-commercial farms, which was in accordance with the highest ratio of these farm types in the veterinarians' practices (see above section, Number and type of farms visited by the surveyed veterinarians).

AMU practices

Among the surveyed veterinarians, writing prescriptions for antibiotics was a common practice (always: 79.0 percent and usually: 19.0 percent), while selling them to farmers was less frequent (always: 1.0 percent, usually: 47.0 percent and rarely: 40.0 percent).

In terms of the purpose of antibiotic use, 70.0 percent of veterinarians used antibiotics for treating diseases. Only 26.0 percent reported administering these substances for prevention of diseases. None of the interviewed veterinarians used antibiotics for enhancing animal growth or production.

When comparing the frequency of group and individual treatments, 96.0 percent of veterinarians reported that they gave antibiotics only to the sick animals in all cases, while treating all animals in the pen, and not just the ill ones, was a less common practice. Giving antibiotics to all animals on the farm was least frequently reported (82.0 percent of veterinarians rarely administered these drugs to the whole farm). The choice between individual and group treatment was usually influenced by the treated species (80.0 percent of veterinarians) and the age group of animals (60.0 percent of veterinarians).

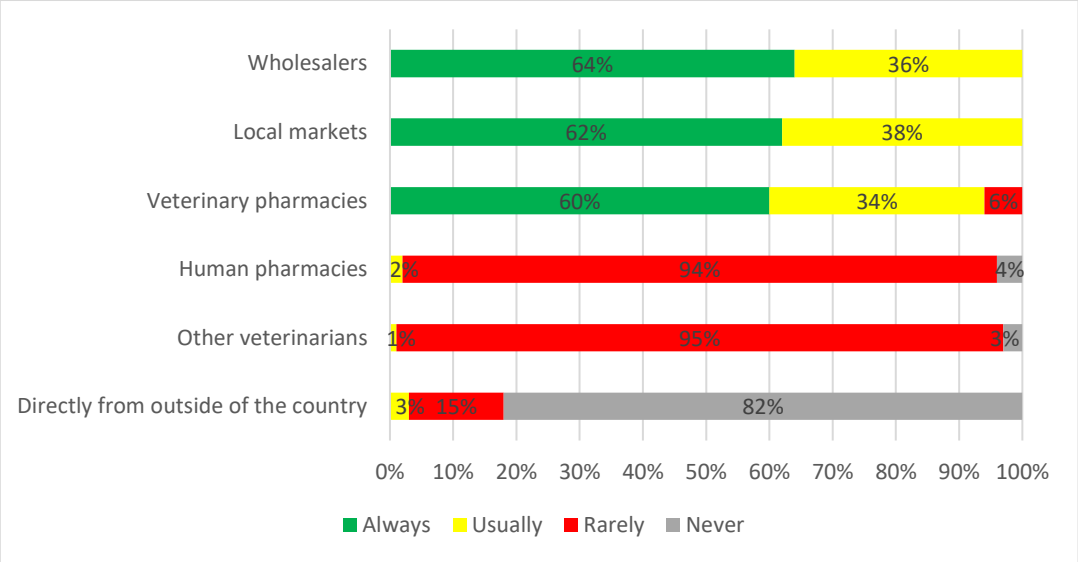
Almost all veterinarians (91.0 percent) reported that they always examine the animals before advising antibiotic use and the other 9.0 percent also did this usually.

Around three-quarters of veterinarians (72.0 percent) reported that they found antibiotics as effective as they were previously, 26.0 percent found them a little less effective, and only 2.0 percent thought that they were much less effective than previously.

All veterinarians reported always informing the farmers about the withdrawal period when advising antibiotic use.

Common sources of antibiotics

Figure 35. Antibiotic sources of veterinarians (Total: 100 veterinarians)



Source: Authors' own elaboration.

Wholesalers, local markets and veterinary pharmacies were equally represented as sources where the surveyed veterinarians obtained antibiotics. The surveyed veterinarians obtained negligible amounts of antibiotics from human pharmacies, other veterinarians, and from outside of the country.

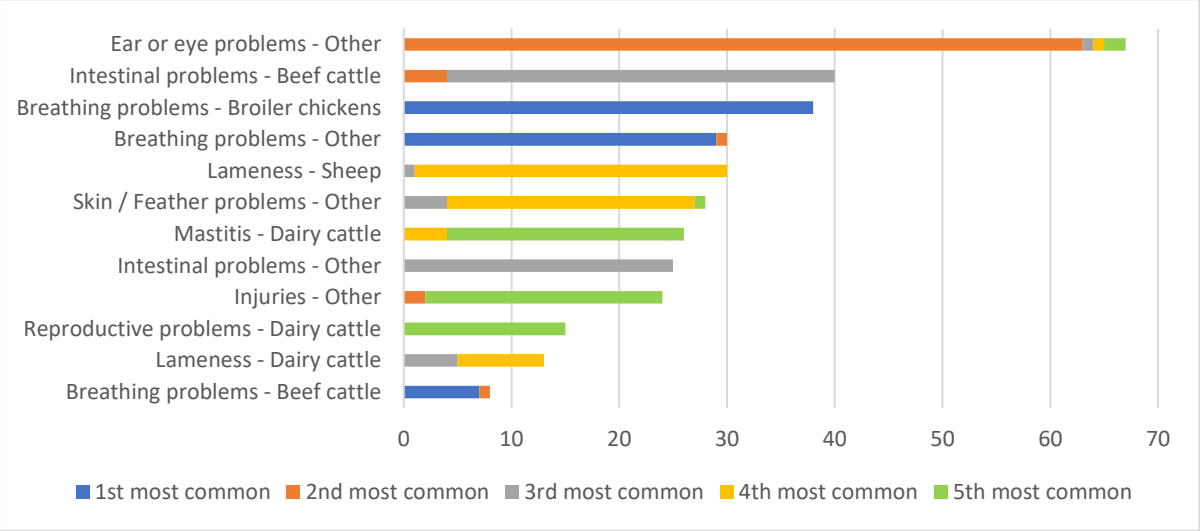
Impact of COVID-19

During or after the lockdown due to COVID-19, only 3 to 5 percent of veterinarians experienced problems that could impact animal health (e.g. difficulties in accessing farms or antibiotics). Furthermore, none of the professionals observed increased mortality in their practice.

Most common health issues or syndromes

The surveyed veterinarians listed the following diseases as the most commonly diagnosed problems in their practice (combining the top five answers of each veterinarian):

Figure 36. Most common health issues diagnosed by the surveyed veterinarians (Total: 71 of 100 veterinarians replied)



Note: Category "Other" mainly refers to dogs and cats.

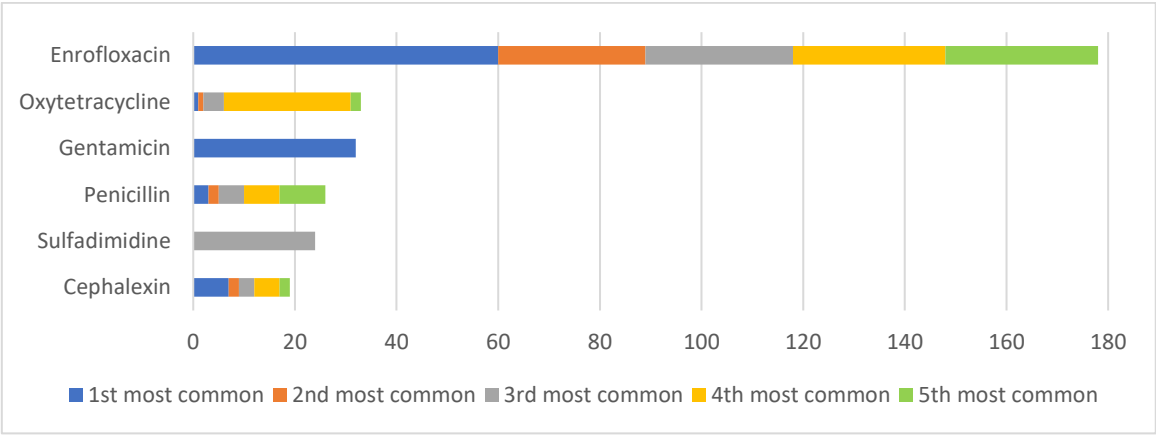
Source: Authors' own elaboration.

In addition to ear and eye problems in the "Other" category (mainly dogs and cats), respiratory and intestinal problems were most frequently diagnosed by the veterinarians. These problems were reported mainly in cattle, chickens and pets. Diagnosing lameness in sheep and mastitis in dairy cattle was reported by a high number of veterinarians, mainly as the fourth and fifth most common illnesses.

Antimicrobial use

The surveyed veterinarians listed the following antimicrobials as the most commonly used substances in their practice (combining the top five answers of each veterinarian):

Figure 37. Antibiotics most commonly advised by the surveyed veterinarians (Total: 100 veterinarians)



Source: Authors' own elaboration.

Among the antibiotics, enrofloxacin was by far the most commonly advised substance. Drugs were mainly given as treatment for adult animals.

Importance of antibiotics for different health issues or syndromes (according to veterinarians)

Table 37. Importance and common use of antibiotics according to veterinarians (Total: 100 veterinarians)

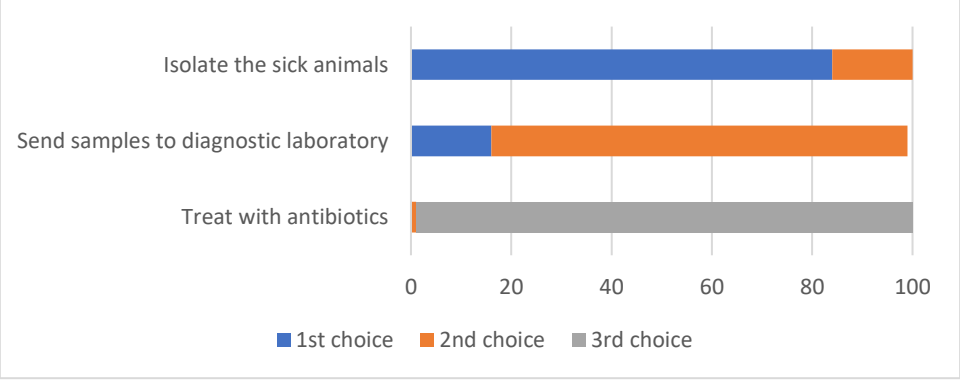
Health issues/syndromes	Ratio of veterinarians reporting importance of antibiotics for this issue	Ratio of veterinarians reporting common use of antibiotics for this issue
Breathing problems or pneumonia	100%	55.0%
Mastitis	100%	55.0%
Lameness	100%	49.0%
Feather or skin problems	99.0%	47.0%
Animals are to be stressed (weaned, surgery, grouped, transferred)	98.0%	17.0%
Not eating or abnormal stools	96.0%	47.0%
Other animals are dying	96.0%	7.0%
Reproductive problems	62.0%	13.0%
Nervous system problems	53.0%	1.0%
Improved growth or production of milk or eggs	21.0%	1.0%

Source: Authors' own elaboration.

According to the surveyed veterinarians, antibiotics were most important and commonly used for treating breathing problems and mastitis, followed by lameness and feather or skin problems. Surprisingly, 21 percent of veterinarians thought that antibiotics were commonly used for growth promotion, although none of them reported using antibiotics for this purpose (see previous section, AMU practices).

Measures in case of disease

Figure 38. Measures taken in case of disease by the surveyed veterinarians (Total: 100 veterinarians)



Source: Authors' own elaboration.

For 84.0 percent of veterinarians, isolation of the sick animals was the first-choice measure when diseases occurred. Sending samples to diagnostic laboratory was listed as the second-choice

measure by most (83.0 percent) veterinarians and treatment with antibiotics was the third choice only (99.0 percent).

Most veterinarians would send samples to the laboratory regardless of whether it is a single case or a disease outbreak, and if it occurred in a herd that they knew or not.

Laboratory diagnostics

All veterinarians stated that they had good access to a veterinary diagnostic laboratory, and that antimicrobial susceptibility testing was available at the laboratories that they worked with for an additional fee. They all reported using previous antimicrobial susceptibility results for treatment decisions, and that they would change the prescribed treatment based on new laboratory findings.

VETERINARY PHARMACY SURVEYS

GENERAL DATA OF SURVEYS

Total number of surveys: 100

Note: 29 percent participants refused to answer question 10, due to too many sub-questions.

Date of surveys

- First survey: 01 July 2022
- Last survey: 30 August 2022

Distribution of surveys (Entity)

- Republic of Srpska 48 (48.0 percent)
- Federation of BiH 52 (52.0 percent)

INFORMATION ON PARTICIPANTS INVOLVED IN THE SURVEY

Role and education of participants

Among the surveyed pharmacy personnel:

- 93.0 percent were veterinary pharmacists;
- 15.0 percent were the owner or co-owner of the veterinary pharmacy;
- 23.0 percent were the manager of the veterinary pharmacy; and
- 99.0 percent were employees.

Note: More than one answer could be provided.

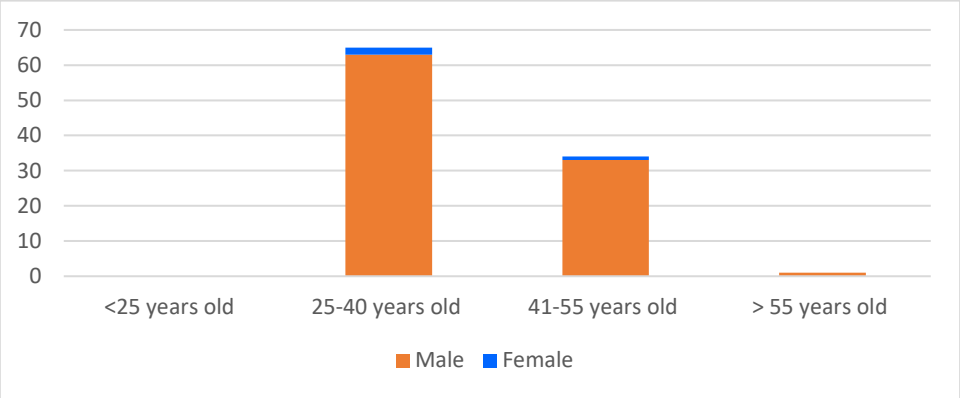
The highest education of veterinary pharmacy personnel was university (98.0 percent), college (1.0 percent), or high school (1.0 percent). They all had information on AMR included in their training or education.

Number of years veterinary pharmacy personnel practiced the profession

- Median: 12 years
- Range: 5–25 years

Age and gender of participants

Figure 39. Age and gender distribution of veterinary pharmacy personnel participating in the survey (Total: 100 pharmacies)



Source: Authors' own elaboration.

The majority of the surveyed pharmacy personnel were male, and the highest number were between the ages of 25 and 40 years (63.0% percent) and 41 and 55 years (33.0% percent).

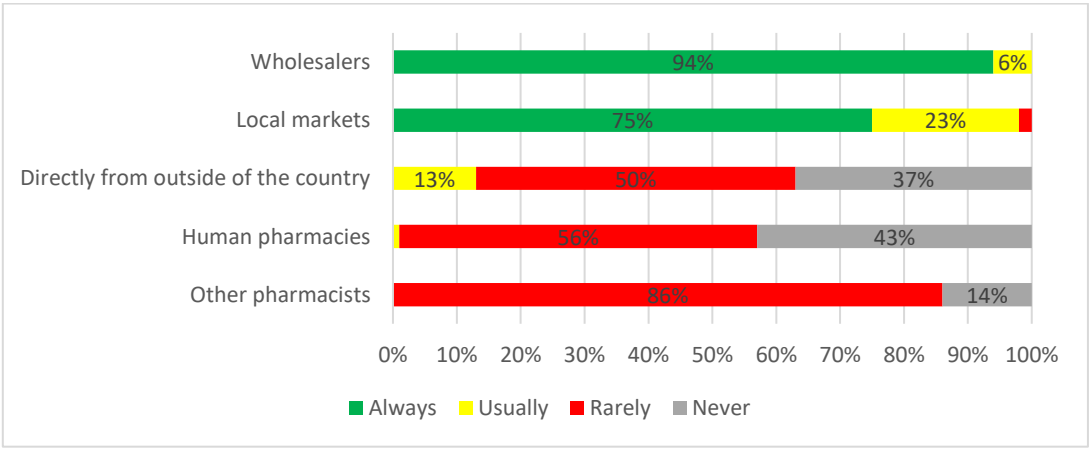
Pharmacy record availability

The names of antibiotics sold per year or per purchase were the most commonly recorded AMU related data among the surveyed veterinary pharmacies (100 percent). Other information on the names, value or volume of antibiotics sold (per year, client, purchase or animal species) are represented in Annex 6 and were recorded by most of the surveyed pharmacies.

INFORMATION ON AMU

Obtaining and selling medication

Figure 40. Antibiotic sources of veterinary pharmacies (Total: 100 pharmacies)



Source: Authors' own elaboration.

The most common way of obtaining antibiotics by the surveyed pharmacies was to buy from wholesalers and at the local market. Pharmacies sold most of these medicines to farmers or the

public and to official veterinarians. Requiring a prescription for purchasing antibiotics was always done by 76.0 percent of the surveyed pharmacists, and usually by 24.0 percent.

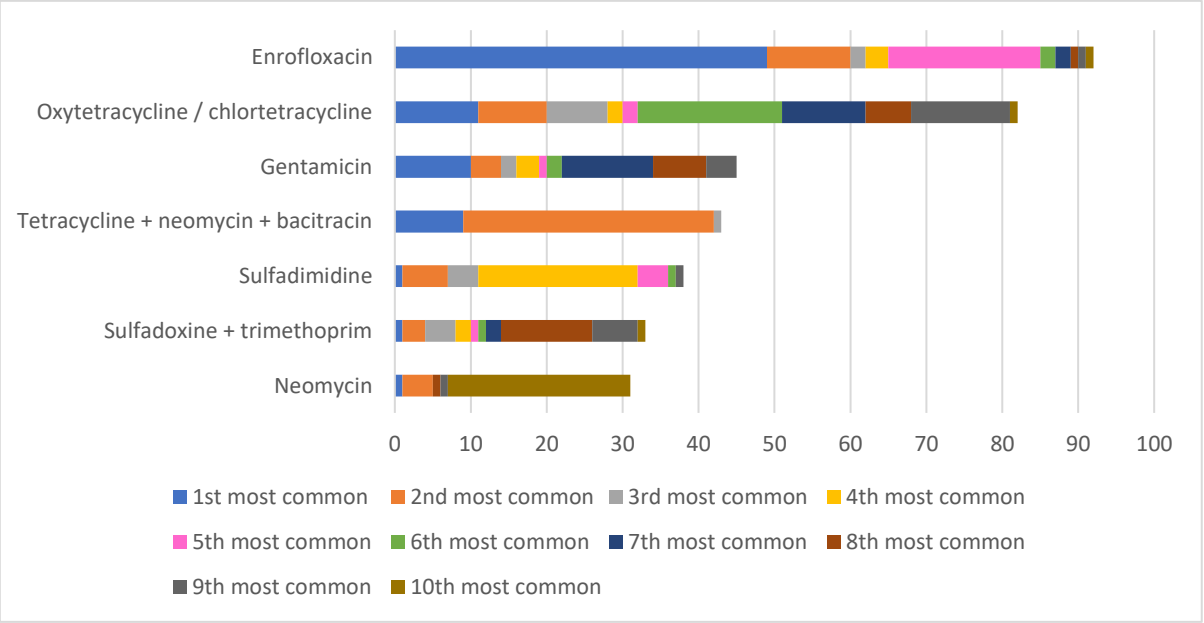
Regarding the efficacy of antibiotics, 78.0 percent of pharmacists believed that antibiotics are as effective as they always were, 21.0 percent found them a little less effective and only 1.0 percent thought that they are much less effective than they were in the past.

98 percent of the surveyed pharmacists reported informing the customers about withdrawal periods when dispensing antimicrobials.

Most frequently sold antimicrobials

The surveyed veterinary pharmacy personnel listed the following antibiotics as the most commonly sold substances (combining the top ten answers of each participant):

Figure 41. Antibiotics most commonly sold by the veterinary pharmacies (Total: 93 of 100 participants replied)



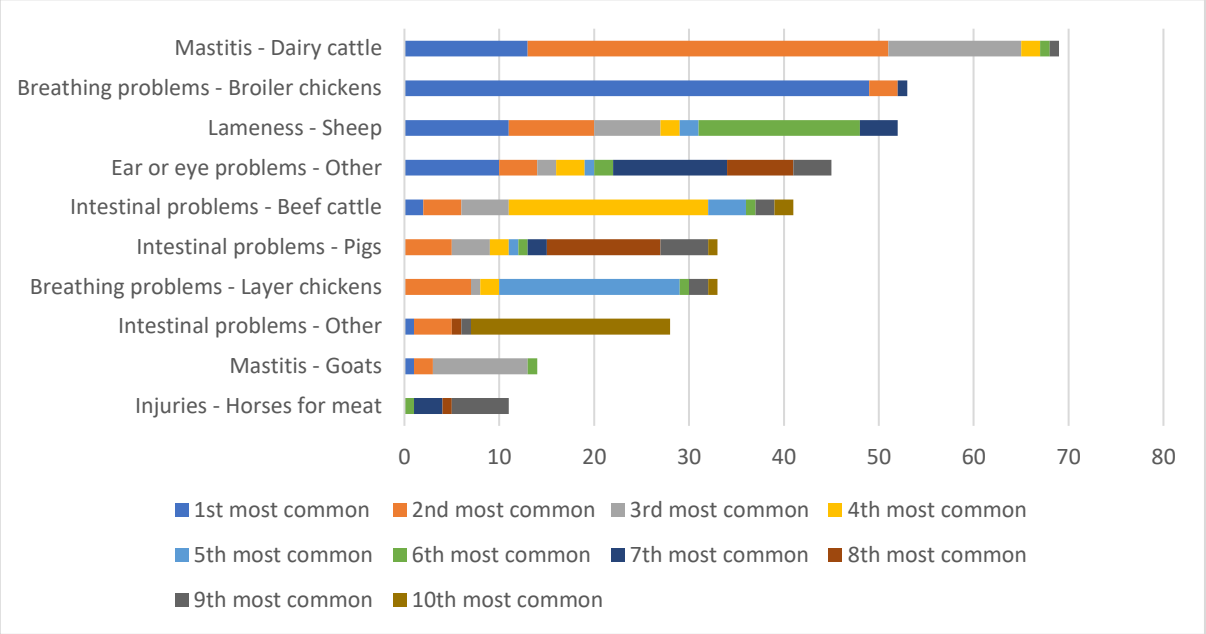
Source: Authors' own elaboration.

Enrofloxacin and tetracyclines (oxytetracycline or chlortetracycline) were the most frequently dispensed active substances, followed by gentamicin, and the combination of tetracycline, neomycin and bacitracin.

Health issues or syndromes most commonly treated with antimicrobials

The surveyed veterinary pharmacy personnel listed the following health issues as the ones most commonly treated with antimicrobials (combining the top ten answers of each participant):

Figure 42. Most common indications of AMU listed by the surveyed veterinary pharmacies (Total: 93 of 100 participants replied)



Note: Category "Other" mainly refers to dogs and cats.

Source: Authors' own elaboration.

The most common reasons for obtaining antimicrobial drugs from the surveyed veterinary pharmacies were mastitis in dairy cattle, breathing problems in broiler chickens and lameness in sheep.

Antimicrobials were most commonly sold for the treatment of disease, usually for use in young animals.

Impact of COVID-19

Pharmacies did not report any problem with accessing antibiotics, disinfectants and vaccines, or having to sell expired antibiotics during or after the lockdown due to COVID-19.

Importance of antibiotics for different health issues or syndromes (according to pharmacy personnel)

Table 38. Importance and common use of antibiotics according to veterinary pharmacy personnel (Total: 93 of 100 participants replied)

Health issue/syndrome	Ratio of participants reporting importance of antibiotics for this issue	Ratio of participants reporting common use of antibiotics for this issue
Lameness	100%	83.0%
Breathing problems or pneumonia	100%	82.0%
Mastitis	100%	77.0%
Animals are to be stressed (weaned, surgery, grouped, transferred)	100%	12.0%
Other animals are dying	100%	6.0%
Not eating or abnormal stools	99.0%	75.0%
Feather or skin problems	99.0%	63.0%
Reproductive problems	99.0%	15.0%
Nervous system problems	94.0%	14.0%
Improved growth or production of milk or eggs	3.0%	0%
Other	0%	0%

Source: Authors' own elaboration.

According to the surveyed veterinary pharmacy personnel, antibiotics were most important and commonly used for treating lameness, breathing problems and mastitis. This was in accordance with the responses collected from veterinarians in this country.

FEED MILL SURVEYS

Total number of surveys: 8

Note: No participants refused to answer any of the questions.

Date of surveys

- First survey: 12 August 2022
- Last survey: 26 August 2022

Except for chicken feed where drugs against coccidiosis were added, none of the surveyed feed mills in BiH prepared and sold medicated feed.

ANNEX 1: SURVEY INSTRUCTIONS

Instructions for the implementation of the antimicrobial use (AMU) survey

Sections:

A. KoboCollect administration
B. Participant selection
C. Survey administration
D. Definitions for the antimicrobial use survey
E. Information to provide to participants on antimicrobial resistance

Appendix 1: Instructions for downloading forms and uploading surveys

A. KoboCollect Administration

1. In order to facilitate survey administration, the FAO will create accounts for a. the FAO national consultant in each country, b. a supervisor in each country and c. for each interviewer.
    a. The designated supervisor of interviewers will be responsible for data validation, and data quality. The account for this person will permit them to:
        i. View all surveys from interviewers in their country in order to ensure that the surveys are complete and correct.
        ii. Once the surveys have been reviewed by the supervisor, the "Submit" button should be clicked to initiate upload.
        iii. Once surveys have been submitted, they cannot be edited.
    b. The interviewer accounts will permit each interviewer to:
        i. enter data;
        ii. view and edit surveys that they have entered; and
        iii. save the surveys as “draft” in order to facilitate review by the supervisor.

        Interviewers will not be able to view other interviewers’ surveys.

2. Please see detailed instructions on downloading the survey forms and uploading the results in Appendix 1.
3. Surveys may be completed offline in areas where online completion is not possible. Surveys should be uploaded to the server as soon as reliable connectivity is available, preferably by the end of the day that the survey was completed.
4. All survey interviews will include the GPS coordinates of the premises. The GPS coordinate data will be destroyed at the conclusion of the project.
5. In order to facilitate quality assurance protocols, contact phone numbers will be collected for all survey interviews. This information will be destroyed at the conclusion of the project.
6. When all surveys have been completed, the dataset needs to be cleared at the country level.
7. Along with the dataset, the service provider must also submit:
    a. an Excel file with free text answers (related to answering “Other” options) with the question number, the answer in the original language, and the corresponding English translation, and
    b. pictures taken at the farms (see description in Section C).

B. Participant Selection

1. Regional Representation:
   Survey participants in each category should be enrolled from each of the selected regions as specified in the letter of agreement (LoA).

   If there are insufficient participants in a particular region, additional participants should be enrolled in other regions in order to achieve the desired national total.

2. Participant Selection:
   Survey participants should be identified and recruited as described in the LoA. If there are less than the required potential participants in any category, (for example feed mills) then efforts should be made to enrol all potential participants.

   If identified potential participants decline to participate in the survey, reasons for refusal should be recorded.

3. Participant Identification:
   i. All individual or personal information of participants will remain confidential.
   ii. Participants will be identified using Codes according to the following system.
   Country–Interviewer number–Survey type–Participant number
      a. Three letter country identifier
         i. Montenegro -MNE
      b. Interviewer identification
         i. Sequential numbers should be assigned to identify each interviewer, e.g. 01, 02, etc.
      c. Survey type identifier
         i. Farm – F
         ii. Veterinarian – V
         iii. Veterinary Pharmacy – P
      d. Participant identification
         i. Sequential numbers should be assigned to each participant interviewed by an interviewer, e.g. 001, 002, 003

   For example: the code for the first farm surveyed by interviewer #2 in Kyrgyzstan would be: Kyr-02–F-001

C. Survey Administration

It is essential that the **Informed Consent document** is explained, read and signed by each participant prior to beginning the survey. A signed copy of the Informed Consent must be provided to the participant and a copy must be retained by the service provider (SP) until the completion of the project. This document must NOT be provided to FAO. To facilitate quality assurance protocols, a contact phone number must be collected from all survey participants and retained until the completion of the project. This contact information will only be used to clarify survey responses and ensure data quality and will be destroyed upon completion of the project. The contact phone number must be linked with the Participant Code.

Feed Mills: Administer the survey to an owner or manager that has knowledge of the antimicrobial use policies and practices of the feed mill.

Veterinary Pharmacies: Administer the survey to an owner or manager that has knowledge of the policies and practices of the veterinary pharmacy.

Veterinarians: Administer the survey to a veterinarian or para-veterinarian who provides direct services to farmers (of the selected priority livestock species within the country).

Farmers: Administer the survey to an owner or manager that has knowledge of the antimicrobial use practices of the farm. The survey for farmers consists of several different sections. The sections completed on each farm will depend on the type of animals found on that farm. **All farmers complete Section 1**. **All applicable species-specific sections should also be completed (see diagram below).** The same Participant identification code should be used for all the sections that are completed for one farm.

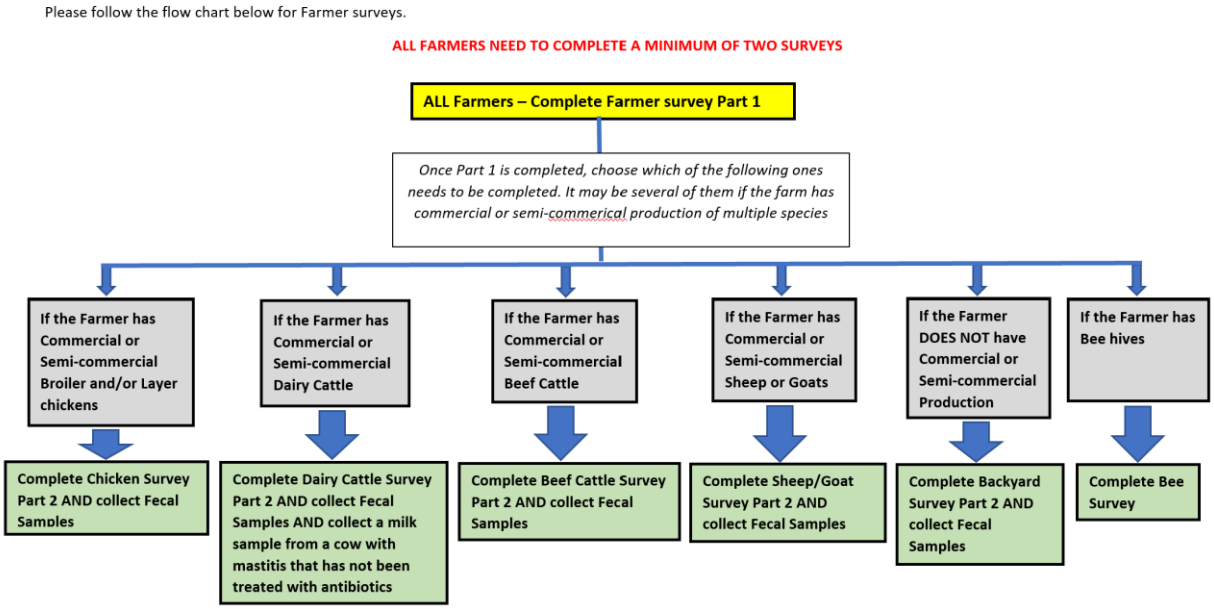
For example:

If a farmer has commercial or semi-commercial broiler chickens, then the *Farmer Section* and the *Chickens Section* should be completed.
If a farmer has commercial or semi-commercial broiler chickens and commercial or semi-commercial bee production, then the *Farmer Section*, the *Chicken Section*, and the *Bee Section* should be completed.
If a farmer does not have any commercial or semi-commercial production, then the *Farmer Section* and the *Backyard Section* should be completed.

While administering the KoboCollect survey to all farmers, the surveyor should take one picture of the veterinary medicines (where they are stored), and at least one other picture of the place where animals are kept. Pictures should be labelled with the Participant Code followed by "Medicines" or "Farm" (for the first and second type of pictures, respectively).

Chicken survey: When completing the *Chicken Section*, questions referring to birds should only be answered with regards to chickens. Other types of poultry are not included in this section of the questionnaire

Cattle surveys: If cattle are kept for dual purpose (both for meat and milk), then the Dairy Cattle survey should be completed



In the survey, there are directions to collect available **records** from participants for the previous 12 months if they are available. It is important to note that these records should be collected only IF the participant is willing to share these. Provision of these records is NOT a requirement of participation. However, if requested records are available and the participant is not willing to provide these, this should be recorded in the comments section at the end of the survey, as well as any reasons given for this decision.

In the survey, if there are questions that participants are **not willing to answer**, record this where indicated in the survey and provide the reasons given for not answering. Participants should not be pressured to provide answers; however, the interviewer should also avoid suggesting that not all questions need to be answered.

When misconceptions are identified, provide explanations and clarifications as described in Section E.

When the survey has been completed, provide the participant with the Antimicrobial Resistance information leaflet.

D. Definitions for the Antimicrobial Use Survey

Note: When translating these definitions, the terms used should be the same as the terms used in the KoboCollect survey.

Antimicrobial: antimicrobials are substances that kill or stop micro-organisms from growing and that help us treat diseases caused by microbes in humans, livestock, fish, plants and pets. For this survey, we are asking about antimicrobials that kill or stop bacteria from growing. These are often referred to as antibiotics.

Young animals: animals that have not reached breeding age.

Adult animals: animals that have reached breeding age.

Heifers: > 6 months old but have not given birth.

Piglets: pigs that are suckling the sow

Fattening pigs: pigs between the time of weaning and slaughter

Feed antimicrobials: antimicrobials that are mixed into or spread on top of the animal feed.

Water antimicrobials: antimicrobials that are mixed into the water that the animals drink.

Drench: an antimicrobial liquid that is given directly into the mouth.

Bolus: an antimicrobial tablet that is given directly into the mouth.

Topical: an antimicrobial that is applied to the skin or hooves/feet.

Backyard farm: an enterprise where the animals/birds raised are primarily for the consumption of the household.

Semi-commercial: an enterprise where the animals/birds are raised for the consumption of the household, as well as for sale, however this is not a primary source of income for the farmer.

Commercial: an enterprise where animals/birds are raised primarily for sale and this is a primary source of income for the farmer.

Treatment: antimicrobials given when a disease is present on the farm in at least one animal/bird.

Prevention: antimicrobials given to control disease when animals/birds when it is likely that they will become sick.

Growth promotion: antimicrobials given to make animals/birds grow bigger and/or faster, not to treat or control disease.

Withdrawal times (for vet survey)**:** the time required after giving an antimicrobial to an animal/bird before the animal/bird can be slaughtered for food or the milk or eggs from the animal can be consumed. This is to prevent antimicrobial residues in the meat or the milk, which can cause people to become sick.

On-farm culling: The animal/bird is euthanized and not used for meat.

Education: As part of the curriculum towards a degree or certificate.

Training: Short-term learning opportunity.

E. Information to provide to participants on antimicrobial resistance

The information provided in this section is intended to increase the participants' awareness and understanding of antimicrobial resistance. Other than the question on what antibiotics are, this information should not be provided to the participant until AFTER they have finished the survey.

1. **This information should be provided to the participant <u>immediately after they have answered the question</u>.**

Question:

Do you know what antimicrobials are? Yes No

If yes, please circle all that apply:

medicine that prevents disease
medicine that kills disease
medicine that kills germs
medicine that kills bacteria
medicine that makes animals grow faster/bigger
medicine that kills viruses
medicine that kills parasites
Other: _____

Answers:

- If participant answers **No**
  - Microorganisms are everywhere and include bacteria, viruses, parasites and fungi. They include bacteria that can sometimes cause disease and infection in humans, animals and plants.
  - Antimicrobials are substances that kill or stop microorganisms from growing and that help us treat diseases caused by microbes in humans, livestock, fish, plants and pets. For this survey, we are asking about antimicrobials that kill or stop bacteria from growing. These are often referred to as antibiotics.

- If participant answers **Yes** to the first part AND answers **Yes to either "medicine that kills viruses"** or **"medicine that kills parasites"**:
  - Antimicrobials are substances that kill or stop microorganisms from growing and that help us treat diseases caused by microbes in humans, livestock, fish, plants and pets. For this survey, we are only asking about antimicrobials that kill or stop <u>bacteria</u> from growing. These are often referred to as antibiotics.

2. **The information for the questions below should be provided to the participant <u>at the conclusion of the survey</u>**

Question:

If the antimicrobials that you have become expired, what do you do?

Use them
Throw them in the garbage
Consult with a veterinarian (if yes pharmacy, private, government)
Pour them down the drain/sink
Return them to where you purchased them
I don't look at the expiration date
Expiration date is not on the medications I use

Answers:

- If answer **"Use them"** or **"I don't look at the expiration date"**:
  - Expired medicines may have lost much of their potency or might even be harmful to the diseased animal.
  - They may also contribute to the development of resistant bacteria in the animal, herd or flock, which may make it more difficult to treat infections in these animals in the future.
- If answer **"Throw them in the garbage"** or **"Pour them down the drain/sink"**
  - Expired medicines may be harmful to the environment. They may contribute to the development of resistant bacteria in the environment, which may make it more difficult to treat infections in animals and people in the future. They should be returned to the retailer, e.g. pharmacy, if possible.
- If answer **"Expiration date is not on the medications I use"**:
  - This may be an indication that the medication you are using is not made by a reputable company. Medications are effective only for a specific time period.
  - Expired medicines may have lost much of their potency or might even be harmful to the diseased animal.
  - They may also contribute to the development of resistant bacteria in the animal, herd or flock, which may make it more difficult to treat infections in these animals in the future.

Question: How much do you agree with the following statements:

You can stop giving antimicrobials to an animal if their symptoms are improving

If **agree**: Antimicrobials should be given until the end of the period that is on the label or was recommended by your veterinarian. Even when an animal's symptoms are improving, the bacteria that caused the symptoms may still be present and if you stop giving the antimicrobials, the bacteria will cause disease again and the antimicrobials may not work at all because bacteria have become resistant.

If antibiotics are given too often they might stop working

If **disagree**:

Bacteria can become resistant to antibiotics when repeatedly exposed to them and then the antibiotic will not work the way it used to. Using antibiotics only when necessary will help to avoid this.

Giving antimicrobials to healthy animals will prevent them from getting sick in the future

If **agree**:

Antimicrobials can treat diseases caused by bacteria, sometimes just before symptoms appear. However, antimicrobials cannot prevent animals from getting diseases in the future.

Using vaccines can prevent the use of antibiotics

If **disagree**:

Vaccines for specific diseases can protect animals from becoming sick with those diseases. When the animals stay healthy, the antimicrobials are not needed.

Animals can transmit disease to humans

If **disagree**:

Some microorganisms can be present in more than one host or species, including both animals and people. These microorganisms can spread from animals to

humans, through food, direct contact or the environment. Sometimes these microorganisms do not make animals sick but can make people ill.

Antimicrobial use in animals does not affect human health

If **agree**:

Antimicrobial use in animals can affect human health in several different ways. When microorganisms become resistant to a particular antimicrobial, they can then infect different hosts, including humans, through the food chain or the environment. The antimicrobial will then no longer work to treat the infection or disease in humans.

Antimicrobial use in animals can also affect human health when antimicrobials are still present in meat, milk, or honey when consumed by people. This is called antimicrobial residue and can cause problems in people who are allergic or have a negative physical reaction when exposed to these antimicrobials.

Antimicrobials may be freely discarded without having an action/effect on the environment

If **agree**:

When antimicrobials are discarded improperly, they can persist in the environment. This can lead to antimicrobial resistance.

Antimicrobial resistance occurs when antibiotics are found in the meat or milk of an animal.

If **agree**:

When antimicrobials are found in the meat or milk of an animal or in honey, this is an antimicrobial residue. Antimicrobial residues can cause problems in people who are allergic or have a negative physical reaction when exposed to these antimicrobials. However, antimicrobial resistance is when microorganisms become resistant to a particular antimicrobial. The antimicrobial will then no longer work to treat the infection or disease in animals or humans.

When you use antimicrobials, there is a certain number of days you should wait before selling the animals for slaughter, selling eggs, milk or honey.

If **disagree**:

When animals or birds or bees are given antimicrobials, the antimicrobials can be present in the meat, milk, eggs or honey for a certain number of days after the last time they were given. When antimicrobials are still present in meat, milk, eggs or honey when it is consumed by people, this is called antimicrobial residue and can cause problems in people who are allergic or have a negative physical reaction when exposed to these antimicrobials.

With prevention and early detection, you can reduce the use of antimicrobials

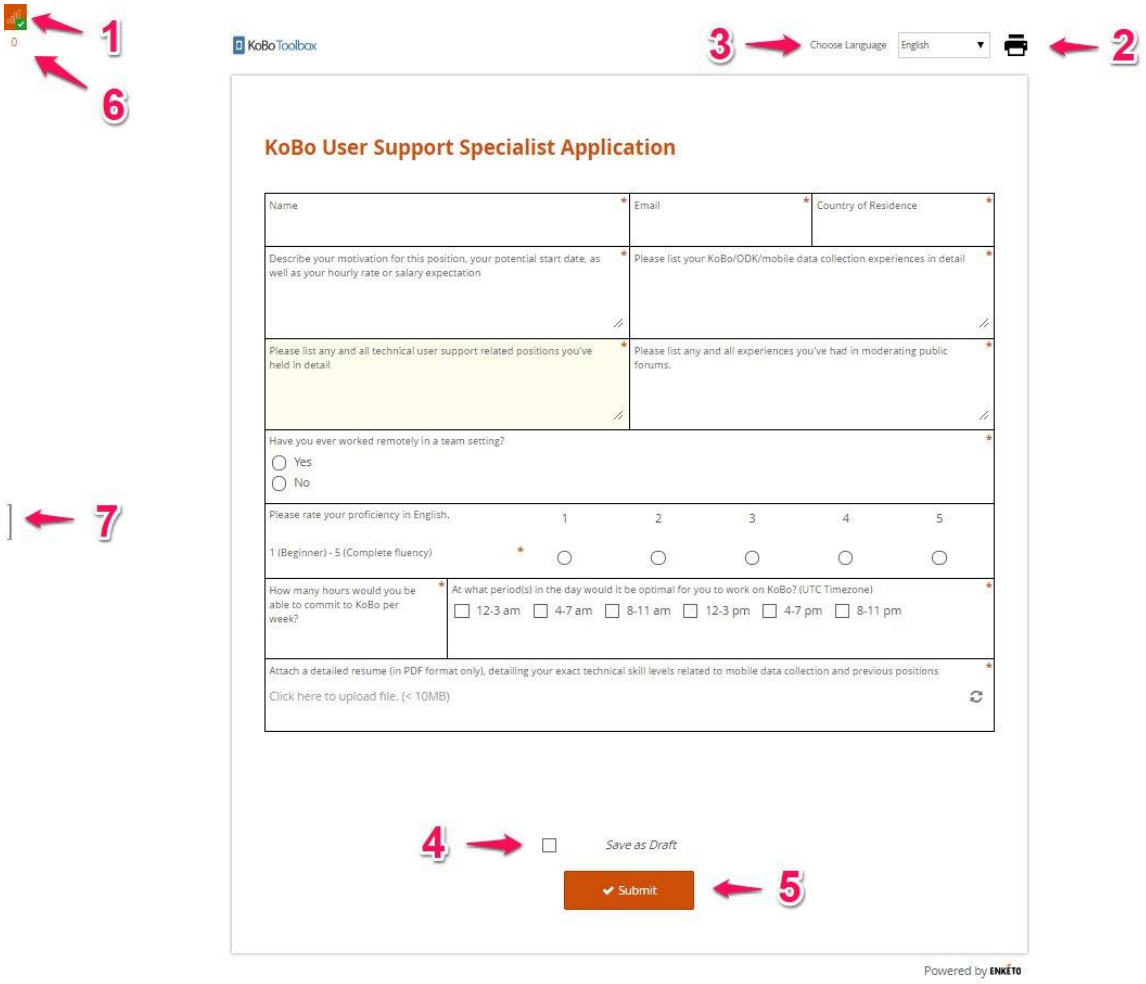
If **disagree**:

When animals/birds/bees are fed a good diet, are in a good environment, and are not exposed to other animals/birds/bees that are carrying disease, they are less likely to get sick and require antimicrobial treatment. Therefore, disease is prevented and antimicrobial use is reduced. If disease in animals/birds/bees is detected when they first become sick or when it is present in only a few animals/birds/bees, then less antimicrobials are often required to make the animals/birds/bees healthy again. It is also possible that less animals/birds/bees will die.

Appendix 1: Instructions for downloading forms and uploading surveys

In the drop-down menu under "Collect data," you have several options available:

Choose “Online-Offline (multiple submission)”: This allows online and offline submissions and is the best option for collecting data in the field. Then press “OPEN” to open the survey form to a new tab in your browser. Once the form is opened, you should see a screen like the one shown in the image below:



1. To enable offline data entry:

    a) Open the survey link provided (as was done during the pre-testing).

    b) Select “Add to Home screen” from the settings.

    c) Touch and hold the “Add” tab to add it to the home screen.

    d) The KoboCollect icon will appear on the screen of the tablet and the Interviewer will easily open the file from the screen during the surveys.

2. Printer icon: The printer icon provides you access to save it as a PDF version. For this, press the printer icon and then select Destination (“Save as PDF” to save your survey form as a PDF).

3. Choose language: The survey is available in various languages used in the Europe and Central Asia region. You're able to toggle between the default language (English) and other languages present in the survey form.

4. Save as draft: Use this feature to edit or update the record before submitting it to the KoboToolbox server. Once you have checked "Save as Draft" you will have an option to "Save Draft." The draft record gets queued but does not sync with KoboToolbox server. To sync it with the server the Supervisor will open the record from the queued list and uncheck "Save as Draft" and press "Submit."

5. Submit: The Supervisor will press the "Submit" button once the information in a survey is verified as final and complete and ready to be uploaded to the KoboToolbox server. After pressing the "Submit" button, you will not have an option to edit the records on your device.

6. Queued records counter: The queued records counter shows you the total number of records submitted and waiting to be uploaded to a server. The queued records are uploaded automatically in the background every 5 minutes when the web page is open and an internet connection is available. The application will always attempt to upload data immediately and will retry until a connection has been established again.

All synchronization is proofed even against poor Internet connection quality. Should a connection time out or be interrupted while a specific form is being transferred, it will be resent with the next upload attempt. The server will not integrate half received data in this case. Only when a record has been uploaded successfully and the server confirms receipt will the survey data be removed from the upload queue.

7. Queue records pane: Clicking the side button shows you the records that are available as drafts (which can still be edited) and finalized submitted records queued to be uploaded to the server with an internet connection.

8. Open-ended Questions:

Questions that are answered using text in the language of the country, for example "If other, please specify," will be recorded in the database in the original language. In addition, an Excel file should be created with the following columns:

Participant code	Question number	Original version	Translated English

ANNEX 2: LIST OF ANTIMICROBIALS

Product name	Dosage form	Active substance
ENROXIL 10%	solution for injection	enrofloxacin
ENROXIL 5%	solution for injection	enrofloxacin
ENROXIL 10%	solution for injection	enrofloxacin
MASTIJET FORTE	intramammary suspension	tetracycline hydrochloride, neomycin sulphate, bacitracin, prednisolone
METRICURE	intramammary suspension	cefapirin benzathine
ENGEMYCIN 10%	solution for injection	oxytetracycline
DUPLOCILLIN LA	suspension for injection	benzylpenicillin benzathine, benzylpenicillin procaine
COBACTAN 2.5 %	suspension for injection	cefquinome sulphate
TERRAMYCIN L.A.	solution for injection	oxytetracycline
SYNULOX L.C.	intramammary suspension	amoxicillin trihydrate, clavulanic acid, prednisolone
CLAMOXYL L.A.	suspension for injection	amoxicillin
ORBENIN L.A.	intramammary suspension	cloxacillin
KLAVUXIL®	intramammary suspension	amoxicillin, clavulanic acid, prednisolone
VETOFLOK 10%, 100 mg	oral solution	enrofloxacin
FUVICIN	powder for oral application	oxytetracycline, sulfamonomethoxine sodium
TRIMETOSUL	oral suspension	sulfadoxine, trimethoprim
TRIMETOSUL 48%	suspension for injection	sulfadiazine, trimethoprim
TILOZIN TARTARAT	powder for oral application	tylosin tartrate
TIAVET 20%	solution for injection	tiamulin hydrogen fumarate
SUSTREPEN D	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin sulphate, dexamethasone sodium phosphate
SUSTREPEN	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
SULFAGUANIDIN	tablets	sulfaguanidine

Product name	Dosage form	Active substance
SULFADIMIDIN	tablets	sulfadimidine sodium
GEOMYCIN RETARD 20%, 200 mg/ml	solution for injection	oxytetracycline
GEOMYCIN F	intrauterine tablets	oxytetracycline hydrochloride
BENZAPEN	suspension for injection	benzylpenicillin benzathine, benzylpenicillin procaine
TETRAVET LA	suspension for injection	oxytetracycline
INTRAMICINE	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
VETACOX S	powder for oral application	sulfadimidine sodium
QUINOEX-10	oral solution	enrofloxacin
EGOCIN L.A.	solution for injection	oxytetracycline
SULFAMAX 300	powder for oral application	sulfadiazine, trimethoprim
TETRAMAX 500	powder for oral application	oxytetracycline hydrochloride
NEOSULFOX P	powder for oral application	sulfadimidine, neomycin sulphate, oxytetracycline hydrochloride
NEOSULF P	powder for oral application	sulfadimidine, trimethoprim
NEOCYCLIN LA	solution for injection	oxytetracycline
NEOPEN L.A.	suspension for injection application	benzylpenicillin procaine, benzylpenicillin benzathine
NEOTYL 200	solution for injection	tylosin tartrate
NEOLI-SPEC	solution for injection	lincomycin, spectinomycin
NEOGENT	solution for injection	gentamicin
NEOSULF	solution for injection	sulfadimidine sodium, trimethoprim
NEOSTREP	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
OXYKEL RETARD	solution for injection	oxytetracycline
COMBIKEL 40	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
COMBIKEL 40 L.A.	suspension for injection	benzylpenicillin benzathine, benzylpenicillin procaine, dihydrostreptomycin
PENIKAN P	intramammary suspension	benzylpenicillin procaine, kanamycin sulphate, prednisolone

Product name	Dosage form	Active substance
KELACYCLINE OBLETE	tablets	chlortetracycline
CEPOREX	suspension for injection	cephalexin
VEYXYL® LA 20%	suspension for injection	amoxicillin
TRIMETOX®240	solution for injection	sulfadoxine, trimethoprim
GENTAKEL 10	solution for injection	gentamicin
TYLOKEL 20	solution for injection	tylosin tartrate
ENGEMYCIN SPRAY	spray	oxytetracycline
NEOSTREP L.A.	suspension for injection	benzylpenicillin benzathine, benzylpenicillin procaine, dihydrostreptomycin
NEOLISPEC P-44	powder for oral application	lincomycin, spectinomycin
NEO-PENICILLIN	powder for oral application	benzylpenicillin procaine, benzylpenicillin potassium
VETASTREP	powder for oral application	streptomycin sulphate
VETACIKLIN	powder for oral application	oxytetracycline
VETA EKO FAH	powder for oral application	oxytetracycline hydrochloride, streptomycin sulphate, vitamin C
LINCO SPECTIN 100	powder for oral application	lincomycin, spectinomycin
LINCO SPECTIN 44	premix	lincomycin, spectinomycin
SYNULOX RTU	suspension for injection	amoxicillin trihydrate, clavulanic acid
GENTAMICIN 80 mg/ml	solution for injection	gentamicin
OTIBIOVIN	solution drops for ear	gentamicin
DUPHAPEN STREP	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
PENTOMYCIN	solution for injection	benzylpenicillin procaine, dihydrostreptomycin sulphate
DUOCYCLINE LA 200mg/ml	solution for injection	oxytetracycline
TRIOXYL LA 150mg/ml	suspension for injection	amoxicillin
GAMARET INTRAMAMARNA SUSPENZIJA	intramammary suspension	novobiocin sodium, neomycin sulphate, benzylpenicillin procaine, dihydrostreptomycin sulphate

Product name	Dosage form	Active substance
OTOMAX	suspension	gentamicin
LIMOXIN-200 L.A.	solution for injection	oxytetracycline
INTERFLOX-100	solution for injection	enrofloxacin
BIOCILLIN-150 L.A.	solution for injection	amoxicillin
INTERTRIM L.A.	solution for injection	sulfadoxine, trimethoprim
PENSTREP-400 L.A.	solution for injection	benzylpenicillin benzathine, benzylpenicillin procaine, dihydrostreptomycin
LIMOXIN-25 SPRAY	spray	oxytetracycline
SUANOVIL 20	suspension for injection	spiramycin
COLISULTRIX	powder for oral application	trimethoprim, colistin sulphate
REMACYCLINE L.A.	solution for injection	oxytetracycline
ENRODIAN	suspension for oral application	enrofloxacin, kaolin, pectin
DOKSILAN-C 20	powder for oral application	doxycycline, ascorbic acid
NEOMULIN DHC-P	powder for oral application	tiamulin hydrogen fumarate, doxycycline hyclate
NEOFENICOL inj.	solution for injection	florfenicol
NEOFLOXACIN-S 10%	solution for injection	enrofloxacin
ORBENIN EXTRA DRY COW	intramammary suspension	cloxacillin
TETRA-DELTA	oil suspension	novobiocin, neomycin sulphate, benzylpenicillin procaine, dihydrostreptomycin sulphate, prednisolone
DRAXXIN	suspension for injection	tulathromycin
GANADEXIL ENROFLOXACINA	solution in drinking water	enrofloxacin, benzyl alcohol
INVEMOX 15% L.A.	suspension for injection	amoxicillin
COBACTAN LC	intramammary ointment	cefquinome sulphate
PARACILLIN SP	powder for oral application	amoxicillin
VETRIMOXIN 50	powder for oral application	amoxicillin

Product name	Dosage form	Active substance
QUINOCOL	solution	enrofloxacin, colistin sulphate
MASTIDRY	intramammary suspension	ampicillin, cloxacillin
MASTIQUICK	intramammary suspension	benzylpenicillin procaine, streptomycin sulphate, neomycin sulphate, prednisolone
KLAVUXIL	suspension for injection	amoxicillin trihydrate, clavulanic acid
CEPHALEXIN	suspension for injection	cephalexin
CONVENIA	powder	cefovecin
NAXCEL	solution for injection	ceftiofur
PENSTREP-400	solution for injection	benzylpenicillin procaine, dihydrostreptomycin sulphate
INTERFLOX ORAL	oral solution	enrofloxacin
LIMOXIN-100	solution for injection	oxytetracycline
GENTA-100	solution for injection	gentamicin
MACROLAN-200	solution for injection	tylosin tartrate
PROCABEN-LA	solution for injection	benzylpenicillin benzathine, benzylpenicillin procaine
ALAMYCIN LA	solution for injection	oxytetracycline
NOROCLOX DC XTRA	intramammary suspension	cloxacillin
ALAMYCIN AEROSOL	spray	oxytetracycline
PEN & STREP	solution for injection	benzylpenicillin procaine, dihydrostreptomycin sulphate
CEFTIONEL-50	solution for injection	ceftiofur
NEOMULIN 20 %	solution for injection	tiamulin hydrogen fumarate
NEOCEFTIOFUR HCl 5 %	solution for injection	ceftiofur
NEOPEN	suspension for injection	benzylpenicillin procaine, neomycin sulphate
VETADERM	powder	oxytetracycline
MACROLAN WS	powder for oral application	tylosin tartrate
BIOCILLIN-200 WS	powder for oral application	amoxicillin

Product name	Dosage form	Active substance
DOXY- 500 WS	powder for oral application	doxycycline hyclate
LIMOXIN WS	powder for oral application	oxytetracycline
ALISERYL WS	powder for oral application	erythromycin thiocyanate, oxytetracycline hydrochloride, streptomycin sulphate, colistin sulphate, vitamin A, vitamin D3, vitamin E, vitamin B complex, vitamin C, Ca
NCP 3	powder	sulfachloropyridazine sodium
NEOFLOXACIN 10%	oral solution	enrofloxacin
NEOAMOXICILLIN P 20 %	powder for oral application	amoxicillin
NEOCOLLISTIN P	powder for oral application	colistin sulphate
CIPROSOL-200 ORAL	oral solution	ciprofloxacin
INTROFLOR- 300	solution for injection	florfenicol
MASTIPLAN LC	intramammary suspension	cefapirin, prednisolone
INTERSPECTIN-L WS	powder for oral application	lincomycin, spectinomycin
INTERTRIM-480 WS	powder for oral application	sulfadiazine, trimethoprim
FATROXIMIN TOPIC SPRAY	spray	rifaximin
MEDIFLOR 100 WSP	powder for oral application	florfenicol
SULTRIM P	powder for oral application	sulfamethoxazole, trimethoprim
AMPICILIN 10%	powder for oral application	ampicillin
DERMOVET	powder for external application	chlortetracycline
MEDILOZIN 500 WSP	powder for oral application	tylosin tartrate
OTC-VP-40 %	powder for oral application	oxytetracycline
MEDICOL 4.8 WSP	powder for oral application	colistin sulphate
SICCOVET	intramammary suspension	benzylpenicillin procaine, dihydrostreptomycin
DEPOLAC	intramammary suspension	cloxacillin benzathine, neomycin

Product name	Dosage form	Active substance
CORMICINA	solution for injection	benzylpenicillin procaine, dihydrostreptomycin, betamethasone disodium phosphate
FATROXIMIN ENDOUTERINO SCHIUMA	foam	rifaximin
TRIMETOSUL IMM	intramammary suspension	trimethoprim
VETOFLOK L.A.	solution for injection	enrofloxacin
GEOMYCIN RETARD 30% inj.otp.	solution for injection	oxytetracycline
TILOSINA 20% LIQUIDO SINTOFARM	oral solution	tylosin tartrate
TIAMULINA 45 % SINTOFARM	powder for oral application	tiamulin hydrogen fumarate
OSSITETRACICLINA 20% SINTOFARM	powder for oral application	oxytetracycline
COLISTINA SOLFATO 10 % SINTOFARM	powder for oral application	colistin sulphate
TRIGUARD 250	powder for oral application	sulfadimidine, neomycin sulphate, oxytetracycline hydrochloride
ENRON-F	powder for oral application	enrofloxacin
COLIGEN G-100	powder for oral application	gentamicin sulphate
MARBOX	suspension for injection application	marbofloxacin
NEOCYCLIN MULTIVIT WSP	powder for oral application	oxytetracycline, vitamin A, D3, E, B1, B2, B6, B12, PP, K3, C, pantothenic acid
GEOMYCIN	powder for oral application	oxytetracycline
ŽIVIMICIN	powder for oral application	chlortetracycline hydrochloride
ENROCIN 10%	solution for injection	enrofloxacin
ENROCIN-S 10%	solution for injection	enrofloxacin
FLUMEKVIN	powder for oral application	flumequine
HEMOSUL S	solution for injection	sulfamethoxazole, trimethoprim
HEMOSUL P	powder for oral application	sulfamethoxazole, trimethoprim
AMPICILIN P	powder for oral application	ampicillin
TILOZIN 200	solution for injection	tylosin

Product name	Dosage form	Active substance
NEOMICIN 245	powder for oral application	neomycin
HEMUTIN S	solution for injection	tiamulin
OKSITETRACIKLIN LA	solution for injection	oxytetracycline
GENTAMICIN sol.	solution for injection	gentamicin sulphate
STREPTOMICIN SULFAT	powder for oral application	streptomycin sulphate
SYNULOX PALATABLE	tablets	amoxicillin trihydrate, clavulanic acid
LINCOCIN FORTE S	intramammary suspension	lincomycin hydrochloride, neomycin sulphate
ALBADRY PLUS	intramammary suspension	benzylpenicillin procaine, novobiocin sodium
FLORON 100mg/ml	oral solution	florfenicol
FLORON 300mg/ml	solution for injection	florfenicol
FLORON 2 g/100 g	premix	florfenicol
SYNULOX PALATABLE 500 mg	tablets	amoxicillin trihydrate, clavulanic acid
SYNULOX PALATABLE 250 mg	tablets	amoxicillin trihydrate, clavulanic acid
LINCOCIN 40 %	powder for oral application	lincomycin chloride
MEDIFLOR	solution for injection	florfenicol
MEDIFLOX 10%	solution for injection	enrofloxacin
MEDIFLOX 5%	solution for injection	enrofloxacin
MEDIFLOX ORAL	solution for injection	enrofloxacin
NAXCEL CATTLE	suspension for injection	ceftiofur
ZUPREVO	solution for injection	tildipirosin
MARFLOXIN 80 mg	tablets	marbofloxacin
MARFLOXIN 20 mg	tablets	marbofloxacin
MARFLOXIN 5 mg	tablets	marbofloxacin
KAODIAR-S	suspension	neomycin sulphate, kaolin, pectin
CEFTIOKAL 50 mg/ml	suspension for injection	ceftiofur

Product name	Dosage form	Active substance
TYLOVET PULVIS	powder for oral application	tylosin
TYLOVET B-200	solution for injection	tylosin
RODOTIUM 10 %	solution for injection	tiamulin
TILMOVET 30 %	solution for injection	tildiprosin
FLORVIL	solution for injection	florfenicol
PRIMAFUL	solution for injection	oxytetracycline, flunixin
PENOVIL-S	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
MASTIVIL	intramammary suspension	benzylpenicillin procaine, streptomycin sulphate, neomycin sulphate, prednisolone
MASTICOL-DC	intramammary suspension	ampicillin, cloxacillin
VIL-FLOKS	solution for injection	enrofloxacin
MAKROVIL	oral solution	tildiprosin
FAVETRIM	oral suspension	sulfamethoxazole, trimethoprim
VIL-FLOKS	oral solution	enrofloxacin
ALAMYCIN LA 300	solution for injection	oxytetracycline
HEXASOL LA	solution for injection	oxytetracycline, flunixin
ROXACIN	oral solution	enrofloxacin
COLIVETO-4800 plv.	powder for oral application	colistin sulphate
DOXYVETo-50 S	powder for oral application	doxycycline hyclate
PEN-STREP 20/20	suspension for injection	benzylpenicillin procaine, dihydrostreptomycin
FLOROGEN 30%	solution for injection	florfenicol
KLAVUXIL 50 mg	chewing tablets	amoxicillin trihydrate, clavulanic acid
KLAVUXIL 500 mg	chewing tablets	amoxicillin trihydrate, clavulanic acid
OXYVET SPRAY	spray	oxytetracycline
LINCOMYCINE-SPECTINOMYCINE	solution for injection	lincomycin, spectinomycin
CTC	intrauterine tablets	chlortetracycline hydrochloride

Product name	Dosage form	Active substance
ALAMYCIN 10	solution for injection	oxytetracycline
SOLVASOL INJECTION	solution for injection	cephalexin
LACTACLOX	intramammary suspension	ampicillin, cloxacillin
ULTRAPEN LA	solution for injection	benzylpenicillin procaine
NEOPHENICOL P	powder for oral application	florfenicol
DOXIN-200 WS	powder for oral application	doxycycline hyclate, tylosin tartrate
TERRAMYCIN	spray	oxytetracycline
NOROTYL LA	solution for injection	tylosin
FLUMEKS 10%	oral solution	flumequine
VETOCIKLIN P 50 %	powder for oral application	oxytetracycline
TIAMULIN	solution for injection	tiamulin hydrogen fumarate
BIOGENTA	solution for injection	amoxicillin
OXITETRACICLINA 200 L.A.	solution for injection	oxytetracycline
SULFAPRIM	solution for injection	sulfamethazine, trimethoprim
TILOVET	solution for injection	tylosin
AMOKSICILIN- VP-50 %	powder for oral application	amoxicillin
INTRACLOX DC	injector for intramammary	cloxacillin
LINCOMED	powder for oral application	lincomycin
DOXY 10 % ORAL	oral solution	doxycycline
CYCLOSPRAY 78,6 mg/g	spray	chlortetracycline
AMOXICILLIN LA 150 mg/ml	suspension for injection	amoxicillin trihydrate
CEFTIMED	suspension for injection	ceftiofur
NEOFENICOL 10%	solution for injection	florfenicol
OTOXOLAN	suspension	marbofloxacin, clotrimazole
ISADERM 5 mg/g + 1 mg/g	gel	fusidic acid, betamethasone

Product name	Dosage form	Active substance
EGOCIN 20g/100g	oral powder	oxytetracycline chloride
SUPERS SPRAY	spray for external application	chlortetracycline hydrochloride
VELESULF	powder for oral application	sulfamethoxazole, trimethoprim
TRIMETHOSULFA ORALE	oral solution	sulfadiazine, trimethoprim
AMOXICILLINA TRIIDRATO 80%	powder for oral application	amoxicillin trihydrate

ANNEX 3: EDUCATION OF FARMERS

Farmers involved in the survey had education or training in the following areas:

Note: In the surveys, education was defined as: "part of the curriculum towards a degree or certificate" and could be higher education, a master's degree or college education, while training referred to a "short-term learning opportunity."

- Animal health: 1.8 percent had education and 23.3 percent had training. Among these, only one surveyed person was a veterinarian, and he had education and training in animal health, husbandry and pharmacology.
- Animal husbandry: 4.4 percent had education and 34.6 percent had training. This included one veterinarian reporting education and 13 of them reporting training.
- Pharmacology: 0.7 percent had education and 4.4 percent had training. This included one veterinarian.
- Other areas: 3.6 percent had training. These included trainings about beekeeping, milk production, and sheep breeding.

ANNEX 4: FARM RECORD AVAILABILITY

The table below presents (in decreasing order) the ratio of farmers keeping record of certain data related to animal health and animal husbandry.

Type of data	Ratio of farmers keeping record of the data
Births	57.8%
Amount of animals, eggs or milk sold	42.6%
Amount of feed purchased	39.3%
Mortality	32.0%
Vaccination records	28.4%
Net income	28.0%
Prescription records	19.3%
Treatment records	18.9%
Animal medicines purchased	17.5%
Amount of feed manufactured on the farm	17.5%
Veterinarian visits	7.6%
Treatment protocols	3.7%
Other	0.4%

Total: 275 farmers

ANNEX 5: PRACTICE RECORD AVAILABILITY (VETERINARIANS)

The table below presents (in decreasing order) the ratio of veterinarians keeping records of certain data related to their practice and AMU.

Type of data	Ratio of veterinarians keeping record of the data
Type of livestock species in practice	99%
Names of antibiotics sold/prescribed per farm	99%
Names of antibiotics sold or prescribed per farm visit	99%
Names of antibiotics sold or prescribed per year	97%
Number of farms in practice	96%
Size of farms in practice	93%
Volume of each antibiotic sold or prescribed per farm visit	90%
Volume of each antibiotic sold or prescribed per farm	67%
Volume of each antibiotic sold or prescribed per year	51%

Total: 100 veterinarians

ANNEX 6: PHARMACY RECORD AVAILABILITY

The table below presents (in decreasing order) the ratio of veterinary pharmacy personnel keeping records of certain data related to the distribution of antibiotics.

Type of data	Ratio of pharmacies keeping record of the data
Names of antibiotics sold per year	100%
Names of antibiotics sold per purchase	100%
Names of antibiotics sold per client	98%
Volume of each antibiotic sold per purchase	98%
Volume of each antibiotic sold per animal species	98%
Number of animals that antibiotics are to be used in	98%
Species and production stage of animals that antibiotics are sold for	98%
Volume of each antibiotic sold per client	95%
Volume of each antibiotic sold per year	91%
Value of each antibiotic sold per client	86%
Value of each antibiotic sold per year	84%
Names and addresses of clients	67%
Number of clients	65%

Total: 100 pharmacies

The *Understanding Antimicrobial Use in Food and Agriculture* series is a compilation of country reports, each describing antimicrobial use (AMU) practices and awareness of antimicrobial resistance (AMR) in the livestock sector. The data presented in these reports was obtained through knowledge-attitude-practices (KAP) field surveys conducted with farmers of priority livestock production systems, field veterinarians, veterinary pharmacies, and feed mills. This issue of the series summarizes the results of interviews performed in Bosnia and Herzegovina between July and August 2022, involving a total of 538 farmer surveys (from dairy cattle, beef cattle, small ruminant, chicken, pig, bee, and backyard farms), 100 field veterinarians, 100 veterinary pharmacy personnel and 8 feed mills.

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