

## Review Article

### Is Antibiotic Resistance a Problem for the Dairy Industry in Georgia?

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#### Abstract

Antibiotics Resistance (AMR) is a global threat to human health, agriculture, and global ecosystems. The Multisectoral and global answer is required to reduce the risk of antibiotics resistance spreading all around the globe.

Nevertheless, Antibiotics resistance issues are not addressed and investigated in Georgia. There is a significant knowledge gap concerning the spreading of antibiotic resistance in the Georgian agriculture and dairy sector, which generates a big part of animal origin food in Georgia. The article's objective is to review available information about the Georgian dairy sector and raise a question about whether current practices increase the risk of antimicrobial resistance spreading.

Review highlights Georgian dairy sector constraints such as usage of outdated practices and methods in cattle feeding, breeding, milking, and welfare. No control over veterinary medicine sales and usage. Food safety risks are connected to a lack of control of small household farmers. Researches done in the human health sector indicated antibiotic development resistance in *Staphylococcus aureus*, which is one of the familiar sources of bovine mastitis.

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Antibiotics resistance in dairy farming is not yet researched. However, National Food Agency monitoring results on the presence of prohibited antibiotics residual in cattle milk and blood indicates that there are increased risks of antibiotics resistance bacteria development in dairy farming and spreading in the environment through the food chain.

**Keywords:** Antimicrobial resistance; Dairy; Dairy sector; Georgia; *Staphylococcus aureus*

#### Introduction

Antimicrobial Resistance (AMR) is a global concern. According to the World Health Organization (WHO), "Antibiotic resistance is rising to dangerously high levels in all parts of the world. New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectious diseases" [1]. Antibiotics resistance arises when bacteria alter their reaction toward drugs used against bacterial diseases, thereby affecting drug efficiency to treat illness [1]. Resistance may occur in all types of microorganisms; however, antibiotic-resistant pathogenic bacteria present the highest risk to human and animal health. AMR is like a silent pandemic, and combating it is a shared responsibility between human and animal sectors [2].

Nerveless, the global monitoring report highlights historical divisions between human health and other sectors as the most significant risk of containing AMR [3]. More than 110 out of 130 evaluated countries by OIE do not have adequate legislation concerning the manufacturing, import, distribution, and usage of antimicrobial drugs, which thereby leads to mistreatment and overuse of antibiotics [2]. One health approach incorporating humans, animals, plants, and the broader environment is recognized as a means to ensure sufficient action [4].

Antibiotics usage in livestock has played a significant role in the evolution of resistant strains. Antibiotics are often overused in dairy cattle to control mastitis, affecting the development of antimicrobial resistance. Research results regarding the percent of resistance *S. aureus* isolated from milk vary across countries. Research conducted in the USA state that 34.3% (82 out of 239) of *S. aureus* were resistant to at least 1 of ten antimicrobials [5]. According to a study done in Argentina, 53.7% of the 80 random isolates showed resistance on at least one of the three tested antibiotics [6]. In Iran, 56% of 328 samples were resistant to at least one of 10 antimicrobials tested [7].

Resistant *Staphylococcus* strains can spread through the food chain to the environment, consequently increasing the risk to biodiversity and human health [8]. Recent research suggests that bidirectional transmission of strains of *S. aureus* between humans and livestock is not a rare occurrence. In 1962 Methicillin-Resistant *S. aureus* (MRSA) became the most prominent threat and challenge to human health. MRSA infections have spread worldwide, appearing at a high incidence in several countries in Europe, the Americas,

and the Asia-Pacific region. MRSA kills more Americans each year than Parkinson's disease, HIV/AIDS, emphysema, and homicide combined [9]. Different studies suggest that human pandemic clone, CC97 of MRSA, had its origin in cattle from dairy farming [10].

Nevertheless, the risk concerning AMR spreading through the food chain to the environment is not addressed in Georgia. Current practices are not reviewed to evaluate their effects on AMR development. This work aims to review available information about the Georgian dairy sector and raise a question about whether current practices increase the risk of antimicrobial resistance spreading.

### The reported situation of multiple drug resistance bacteria in Georgia

Researchers of clinical samples in Tbilisi Georgia highlight the problem of multiresistant *Staphylococcus aureus* strains spreading in humans. According to research done between 2008-2012, 97% (272 out of 279) of *Staphylococcus aureus* strains were resistant to at least one of 23 antimicrobials tested [11]. To meet global guidelines, in 2017, the Government of Georgia issued a decree approving the National Strategy for Combating Antimicrobial Resistance 2017-2020. According to the decree, multi-resistance of *Staphylococcus aureus* strain in clinical samples taken from hospitals increased by 47% [12].

At the same time, the Georgian National Strategy for Combating Antimicrobial Resistance highlighted that data on the current situation of antimicrobial resistance in Georgia is deficient. Antibiotics consumption and antimicrobial resistance in animal agriculture are even less studied than in the health sector. Inadequate regulations may cause undesirable effects on antimicrobial resistance [12]. Now more than ever, there is a need to fill the knowledge gap and increase awareness about possible risks antimicrobial resistance is bearing.

Georgia is a small country at the intersection of Europe and Asia (Figure 1) in the Caucasus region, with a population of 3.7 million [13]. Moreover, gross domestic product per capita of \$4,345 [14]. The unemployment rate is 12.7% [15]; about half of the employed people, 49.2% are self-employed [15]. Furthermore, in self-employment, the share of employed people in agriculture is very high [16]. The agriculture sector employs 40% of workers [17].

### Dairy Farming in Georgia

Dairy products are in high demand among Georgian consumers, mainly traditional cheese types and fresh milk [19]. Animal husbandry output in Georgian agriculture is 55%, out of which, dairy production is in the first place according to animal production in holdings of all categories [20]. Cattle are the predominant type of livestock, most farmers in all regions owning them in different numbers [21].

Georgia produces up to 555 million tons of milk annually [20]. Family households produce most of the milk and sell it through informal channels. Moreover, a small amount is sold to commercial dairy processing factories [22]. The shares of family holdings in dairy production are 97.9% (Figure 2) [20]. Smallholders mostly produce milk, and it contributes to household livelihoods, food security, and nutrition. Statistics indicate that demand outstrips supply. Lack of supply of big factories compensates for imported products. In 2018, import of dairy products increased by 60% [23].

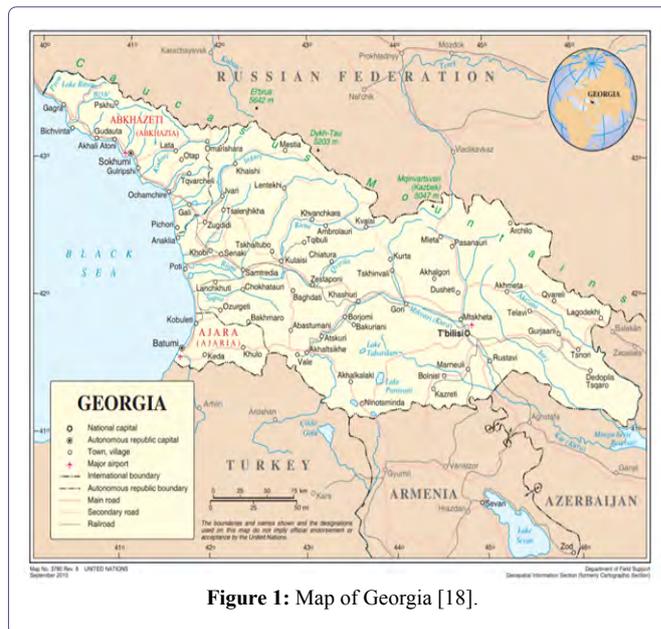


Figure 1: Map of Georgia [18].

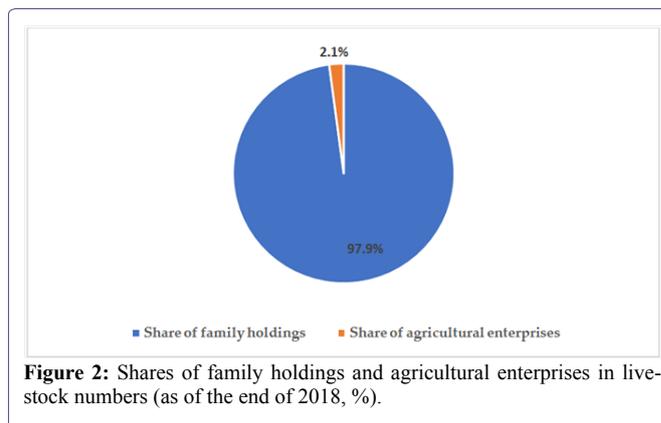
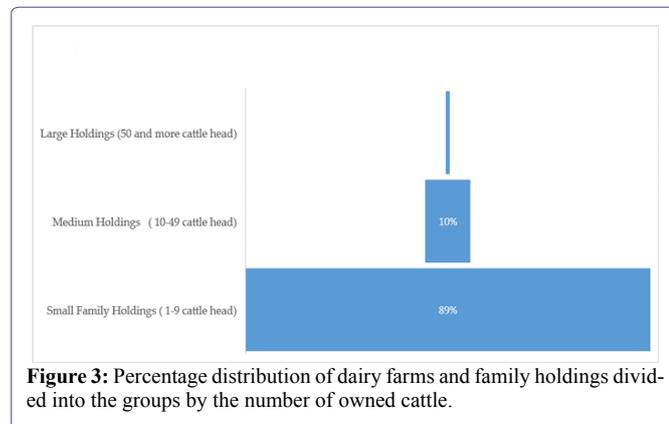


Figure 2: Shares of family holdings and agricultural enterprises in livestock numbers (as of the end of 2018, %).

Dairy farms and family holdings can be divided into the following groups by the number of owned cattle: Small households (1-9 cattle head), medium (10-49 cattle head), large farms (50 and more head) [19,24]. According to the National Food Agency cattle monitoring report, 89% of farms are small family holdings owning more than 50% of Georgian cattle, out of which 76% of family holdings have 1 to 5 cows. Medium and large holdings constitute 10% and 1% of total dairy holdings (Figure 3) [25].

Small household farms take care of cattle themselves, while large farms mainly hire external workers. Most households milk cows manually without any equipment. Working with cattle with hands increases the risk of bacteria transfer from animals to humans and the environment. Equipment available in larger-scale farms is mostly outdated, affects animal yield and health, and does not match the expected hygiene standards. Small family holdings use more than half of the produced product for self-consumption [26]. Farmers produce cheese and other dairy products like butter, yogurt. Small households mostly sell milk directly to neighbors, intermediaries, or the open

market; some deliver milk to wholesalers, milk collection centers, cooperatives, and dairy companies [19].



**Figure 3:** Percentage distribution of dairy farms and family holdings divided into the groups by the number of owned cattle.

According to Baseline Assessment of the Dairy Sector in Georgia (2018), there are 229 Food Business Operators (FBO) registered in Georgia, 73 milk and dairy producers, 57 businesses involved in the dairy trade, 44 raw milk processors, 42 cheese factories [19].

## Animal Husbandry in Georgian farms

### Cows feeding

Small and medium-sized farms primarily use extensional farming, and feeding is seasonal. Farms mainly feed cattle on pastures during summer and corn, hay, and straw in winter. Some farms send animals in the mountains, but as the following service are related to additional costs, farmers need to pay to shepherds, and it is not available for every farm. During wintertime, farmers purchase wheat, corn, and hay, but it also has financial constraints, and farmers often underfeed animals. A small number of commercial farms use on-farm feeding [19,24,27]. Family households cannot provide cattle with the necessary amount of feed; therefore, cattle productivity is very low. The average yield of Georgian cattle is 1,486 liters per year [20]; only 21% of average milk yield compared to Europe [28].

### Cattle breeds and breeding

Mostly all small household farmers have mixed-breed cows without proper origin. Nevertheless, according to the FAO Domestic Animal Diversity Information System, there are seven local breeds in Georgia: Megruli Red, Lesser Caucasus, Greater Caucasus, Georgian Mountain, Dagestan Mountain, Caucasian Brown and Caucasian [29]. Holstein, Brown Swiss, Guernsey, Jersey, Milking Shorthorn and Veli's red are also spread in Georgia [30].

Family households mostly use traditional reproduction or buy calf from neighbors and on open markets. Bulls and cows are often kept together without any control mechanisms producing half breed cattle. Even some cases of inbreeding lead to a decrease in productivity and health, but farmers do not perceive the described issues. Only a small number of farms apply artificial insemination or purchase calf with pure bloodlines [30].

### Cattle veterinary

Government veterinarians provide free vaccinations to cattle

against Anthrax, Epizooticae, Brucellosis, Bunyaviridae, Rabbis and Dermatitis [31]. Medium and large farms have their veterinarians while smaller households receive service from veterinary pharmacies or the veterinary working with nearby large farms. Farmers in veterinary pharmacies can purchase veterinary drugs without prescription and monitoring, presenting the danger of antibiotics misuse, thereby escalating bacterial response change toward overused antibiotics and affecting antibiotic resistance development in microorganisms. There are more than 1200 veterinary drugs registered in Georgia [32]. The government registered more than 300 in 2018 [32]. Drugs are mostly imported and are in the highest demand in the spring and summer, as the number of animal diseases increases during this period [19].

## The Dairy Industry in Georgia and Consumer Demand

The dairy sector in Georgia is developing rapidly. Affected by increased consumer's demand towards quality and safe dairy products and abolishing trade barriers between the EU and Georgia under the Deep and Comprehensive Free Trade Area (DCFTA) [33]. In recent years several dairy associations were created in Georgia and are still under development: Dairy Georgia Association, Georgian Dairy Association, Guild of Cheese Producers and Milk Suppliers Business Association [34].

Nevertheless, consumer awareness still needs to be increased regarding food safety requirements. Dairy market research conducted in 2017 highlighted that consumers do not know how to read and understand labels. The term "ecologically clean" has been used by producers to attract and mislead consumers [34]. In 2019 joined effort was taken to improve consumer awareness and help them make informed decisions. On the 1<sup>st</sup> of March 2019, new food labeling regulations on providing information to consumers came in force. Georgian regulation is aligned with EU Regulation No 1169/2011. It prohibits misleading advertisements and ensures transparency [35,36]. To answer regulation and consumer requirements in 2019, international organizations created mark - "Georgian milk," which promote products made from raw milk and help consumer and dairy producers. The mark is given to dairy factories using only raw milk without milk powder and any vegetable oils [37].

The 2019 government has created 11 quality marks of traditional products, under the label of Protected Geographical Indicator. It protects the appellation of origin, Georgian quality, grass-fed, handmade, mountain produce, fed in the forest (free-range), directly pressed juice, Bio produces and Bioproduction transition. Getting quality marks are voluntary and will support promoting Georgian products. Before receiving the mark, the food business operator should undergo an audit and be subject to permanent control [38].

## Dairy Sector Constraint in Georgia: Uncontrolled Usage of Antibiotics

According to Food and Feed Safety, the Veterinary and Phytosanitary Codex of Georgia, small household farms producing dairy products at home are not obliged to follow the law requirements until 2020. This leads to the uncontrolled production of milk and dairy products under non-hygienic conditions [39]. The National Food Agency of Georgia (NFA) is responsible for controlling law requirements and ensuring that food safety requirements follow up and cannot monitor small dairy households.

National Food Agency controls only registered food business operators while unregistered holdings and factories continue to sell on the open market without constraints, destabilizing the dairy sector [34]. Europe Foundation highlighted the following as nonconformity during the assessment of the government's reform efforts in 2017. According to their recommendation, NFA should pay more attention to controlling untraceable products on the open market [40].

FBOs rarely make laboratory analyses of milk [41]; following is affected by a low level of education, cost of laboratory analyses, and limited access to relevant laboratories. Europe Foundation highlighted that "There are also high risks related to the practice of milk rejected by dairies being sold to unregistered FBOs without any control of quality or safety [40].

Small household farms mainly use outdated primitive techniques and mainly depend on the natural environment. Milk is often stored in inappropriate containers and is not refrigerated. Veterinary medicines are used without prescription and monitoring. Lack of knowledge and outdated practices are among the main challenges of the dairy industry [19,24,26,27,42].

Information about antimicrobial resistance and its risks are not shared by the Ministry of Environment Protection and Agriculture of Georgia, National Food Agency or business associations, and Nongovernmental organization. Small households and food business operators do not have access to the necessary information to make an informed decision about antibiotic usage.

Antibiotics are sold freely and without control in drug stores and veterinary houses. Information about antibiotics or growth support hormones usage is not available. Animal feed is not controlled or monitored. Incorrect and uncontrolled antibiotic usage is unsustainable and can lead to an increased antimicrobial resistance threat to animal and human health sectors.

Currently, antimicrobial resistance issues in Georgian animal husbandry and dairy are not researched yet, but there is some statistical information indicating that high risk of antimicrobial resistance is spread. In 2018 the Ministry of Environment Protection and Agriculture of Georgia prohibited the use of several antibiotics for veterinary purposes (such as chloramphenicol, nitrofurazone and metronidazole) [43]. To control the implementation of regulation changes in 2018 and 2019, the National Food Agency took cattle milk and blood samples and tested the presence of prohibited antibiotics residuals. Research done in 2018 showed that 113 out of 285 milk samples (39%) were contaminated with at least one prohibited antibiotics residual [44]. Similar control was done in 2019 and detected that 457 out of 566 cattle blood samples (80%) were contaminated with prohibited antibiotics residual [45]. Even though the residual of allowed antibiotics is not researched, laboratory analyses done by the National Food Agency on the presence of prohibited antibiotics highlight a lack of knowledge and incorrect unsustainable antibiotic use in animal husbandry and dairy farming, which can lead to a high risk of antimicrobial resistance spreading. Antibiotic residue in milk and blood samples can be affecting the development of antimicrobial resistance, which can quickly spread to the environment through the food chain and affecting the increase of antimicrobial resistance in clinical samples.

## Conclusion

To conclude, the existing knowledge gap does not allow us to know definitely if antimicrobial resistance is developing and spreading through dairy farming to the environment and humans in Georgia. However, available statistics of analyses done on *Staphylococcus aureus* samples taken from the human health sector and on antibiotics residual in cattle from animal husbandry highlight increase of antibiotics resistance increase in *S. aureus* and high level of prohibited antibiotics residual in cattle from dairy farming. The above mentioned indicates that incorrect and uncontrolled antibiotic use in animal husbandries might be a lead cause for antibiotics-resistant development in *S. aureus*. Moreover, highlighting that current agriculture and veterinary practices are not sustainable for the future.

The multispectral approach is required to prevent antimicrobial resistance development in the dairy industry and spread through the environment. Antimicrobial resistance development risk needs to be addressed by all stakeholders more broadly to increase consumer's and farmer's awareness. Researchers are necessary to fill the knowledge gap and evaluate the area for improvements. Information about AMR and its risk needs to be available on government portals and shared by nongovernmental organizations and stakeholders. Veterinary services should be more accessible. Support from different projects and grants can be used to inform small households about Good Hygiene, and Veterinary Practices and farmer's information centers can be used to make information more available for farmers. Changes in regulations are necessary to implement monitoring over veterinary drug sales and usage. Control over small households and unregistered FBOs need to be more comprehensive and stricter.

The threat of a hidden pandemic is very high and requires urgent action from all government and non-government bodies, private sector and international organizations.

## Back Matter

Supplementary Material: Figure S1: Map of Georgia. Map No. 3780 Rev. 6, Department of Field Support Geospatial Information Section (formerly Cartographic Section), UNITED NATIONS September 2015.

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## Author's Contribution

Conceptualization, A.P., K.D.; Validation, A.P., K.D., T.O.; Investigation, K.K.; Resources, T.O., K.K.; Data Curation, K.K.; Writing - Original Draft Preparation, K.K.; Writing - Review & Editing, A.P.; Visualization, K.K.; Supervision, A.P., K.D., T.O.

## Conflicts of Interest

The authors declare no conflict of interest. The sponsors had no role in the design, execution, interpretation, or writing of the study.

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