

*Review Article***Antimicrobial Use and Resistance Issues in Livestock Sector: A Review**Neela Madhav Patnaik^{1*}, Arghyadeep Das² and Kalyan Mandi¹

ICAR-NDRI, Karnal, Haryana, INDIA

¹Division of Dairy Extension²Division of Dairy Economics, Statistics and Management*Corresponding author: neela.patnaik@gmail.com

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Abstract

In the present scenario of rising concerns of mankind towards emerging health issues which were not even in the global scene few years ago, Antimicrobial resistance has taken center stage. Out of the different priorities set by the government of various countries, antimicrobial resistance is a prominent fixture. In Indian context, it is fair enough to say that antimicrobial resistance issues have caught the attention of our policy makers towards a formidable action plan for coming years. Livestock sector in general and dairy sector in particular has been a determining factor as far as antimicrobial use and resistant to infection is concerned in livestock sector. A comprehensive review is needed to understand the different facets of antimicrobial usage in livestock sector and how it is linked to human health so that they do not act as a hindrance to human development is the need of the hour.

Key words: Antimicrobial, Health, Livestock, Milk, Resistance

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Introduction

Livestock plays an important role in improving the nutritional status of low-income households (marginal, small and landless) and create employment opportunities within and beyond the immediate household. The animal productivity depends on four pillars of animal husbandry i.e. breeding, feeding, health care and management practices. But animal productivity is quite dismal due to multiple factors includes poor availability of improved breeds and breeding services, targeted preventive health care, better feeding practices and access to credit facilities. Out of the aforementioned factors, poor health of livestock infected with diseases affects the farmer to a large extent due to the economic burden incurred. It is beyond doubt that when an animal falls sick due to any microbial infection, they are usually treated with antimicrobials

for quick relief and proven effectiveness. Reports in recent years suggest that *Staphylococcus spp.* bacteria has developed resistance to many antibacterial agents. One such example being methicillin resistant *Staphylococcus aureus* (MRSA) has *mecA* gene, which confers resistance and also encodes a penicillin-binding protein (PBP) with decreased affinity for β -lactam antibiotics (Sudhakar *et al.*, 2019). Vertical and horizontal livestock production system intensification of livestock to meet the demands of ever-growing global population coincides with the increase in administration of antimicrobials for different purposes. Barbosa *et al.* (2000) elucidated that Antimicrobial Resistance (AMR) development in livestock sector may be due to overuse and sub-optimal use of antimicrobials. In developing country like India, AMR can bloom into a major health problem in coming years due to easy availability of antimicrobials leading to higher incidence of inappropriate, discriminate usage of antimicrobials thereby greater level of resistance.

Synchrony of Antimicrobial Use in Livestock and AMR Emergence Issues

Antimicrobial agents are defined as any naturally occurring, semi-synthetic or synthetic substance exhibiting antimicrobial activity (killing or inhibiting the growth of microorganisms) which includes agents active against bacteria, protozoa, viruses and fungi. The three major facets of antimicrobial use in livestock can be illustrated as therapeutic (treat clinical diseases), sub therapeutic (growth promoter) and prophylactic (prevention and control of common diseases). The different type of antimicrobial substances includes antibiotics, anti-protozoal, antifungals etc. Antimicrobials used therapeutically in livestock may generate a pool of antimicrobial resistant bacteria (Maron *et al.*, 2013). Mastitis treatment has a potential towards developing antibiotic resistance, as antibiotics used to treat mastitis often have a short duration of therapy. β -lactams are most commonly used in mastitis therapy and have little or no activity against gram negative bacteria (Bansal *et al.*, 2019). Pradhan *et al.* (2019) carried out a study to determine the antimicrobial resistance of 46 isolates obtained from the upper respiratory tract of clinically sick calves with respiratory affections. They reported Ciprofloxacin was most sensitive antibiotic followed by gentamicin. As there are always chances of mixed bacterial infection, for quick recovery it is always necessary to use a broad-spectrum antibiotic. The signs of antimicrobial resistance can be forecasted when antimicrobials that were once successful in fighting infections due to bacteria, viruses and fungi are no more effective against the infections. Indiscriminate and improper use of once-miracle drugs (antimicrobials) cause microbes to develop mutations that render them ineffective and animals will not respond to treatment, performance will suffer and death losses may be on the rise (Landers *et al.*, 2012; Prescott, 2014). Recent decades have witnessed widespread criticism for the use of antimicrobials in livestock production as evident from different reports. Marshall and Levy (2011) and Saini *et al.* (2012) had concerns regarding antimicrobial drugs used in animal husbandry and the threat they may pose to both animal and human health, through the selection of resistance. Patnaik *et al.* (2019) reported that providing quick relief to sick animals i.e. prompt

result was the major factor in prescribing behavior of antimicrobial by 97.50 percent veterinary doctors. Price had a very less effect on their prescribing behavior of 81.67 percent veterinarians perceived that in case of complicated cases they had to go for expensive medicines in order to cure the ailment as proving relief to the livestock was their motto.

Big Question Lies in the Link Between AMR in Livestock and Human Health?

A number of researchers had tried to establish connection on the complex issue pertaining to antimicrobial resistance and use of antimicrobials in humans and animals. The direct contact of humans with livestock can lead to the spread of antimicrobial-resistant bacteria from animals to humans (Chang *et al.*, 2015). The resultant effect of the spread of antimicrobial resistant bacteria to human pathogens is that the antimicrobial drugs are not that much effective in treating human infections (OIE, 2013). Another way where humans are exposed to antimicrobial-resistant bacteria is by consuming them through the food supply. There is a close association between the amount of antimicrobials used in livestock and the rate of development of resistance to these substances. Studies by Uninkrishnan *et al.* (2005) and Scoppetta *et al.* (2016) found antimicrobial residues in milk and milk represents a source where resistant bacteria can enter the human food chain. The authors have devised a three step follow mechanism of antimicrobial residues entering the milk supply illustrated as follows from the researches carried out by Anon, (2007), Boyce, (2008), and WHO, (2014)-

- a. Milch animal treated with antimicrobials produce milk containing antimicrobial residues for a period of time after treatment.
- b. Depending on the severity of the disease and antimicrobial dose administered, treated cows are therefore required to be excluded from the milk supply for a specific time period to ensure that antimicrobial residues no longer remain in their milk.
- c. Antimicrobial residues enter the milk supply when treated animals are returned to the milking herd early or when it retains antimicrobial residues in their system for an extraordinary length of time.

Antimicrobial Resistance Initiatives in Global Scene and India

A historical turn of events took place on 21st September, 2016 when the United Nations General Assembly took place at New York. It was historical in the sense that only the fourth time in UN General Assembly a health topic was discussed after HIV, non-communicable diseases and Ebola. Global leaders comprising the Heads of State and Heads of Delegations have time and again addressed the seriousness and scope of the prevailing situation related to antimicrobial resistance issues. A consensus was arrived among the global leaders towards sustainable, multisector approaches to addressing antimicrobial resistance. In 2017, India finalized its comprehensive and multi-sectoral National Action Plan for strategic containment of AMR. The National Action Plan with the support of all the stakeholders including UN, WHO, FAO and other UN agencies, civil society organizations etc. has undertaken a forward path in a holistic and collaborative

approach towards development and implementation of the national and state action plans on AMR. For meeting the objective of tackling Antimicrobial Resistance (AMR) in livestock sector particularly animal health, Indian Council of Agriculture Research (ICAR) has found support from FAO whose technical and financial support has enabled ICAR to form a network of laboratories at different parts of India in undertaking surveillance of AMR in animal health sector.

Social Science Perspective of Antimicrobial Resistance Issue

Behavioral interventions aimed at sustainable and judicious antimicrobial use should be considered as part of comprehensive One Health AMR action plans. Farmers' knowledge and expectations, risk perception and attitude towards antimicrobial use and AMR effect on-farm antimicrobial use. Although these psychological characteristics differ by type of livestock production, overall and across all sectors, an increased 'knowledge' scores were some of the most significant determinant for antimicrobial use at the farm level. Therefore, knowledge of antimicrobial use and AMR, and expectations on antimicrobial effectiveness should be heavily targeted in the communication with the veterinarian and through educational campaigns for farmers. Moreover, farmers should be more actively involved in the design and evaluation of antimicrobial regulations, since they play an important role in the effectiveness of these measures regarding judicious use of antimicrobials and minimization of the AMR threat for public health. Patnaik *et al.* (2019) in their study revealed that cost incurred in purchase of antimicrobials and its reduction to enhance the profit ranked first though the farmers strongly favored allopathic treatment. This contrasting situation where the dairy farmers want to reduce antimicrobial usage and at the same time have a preference towards allopathic treatment is an opportunistic situation for the extension workers to make the farmers aware on the adverse effects of AMR on livestock and consequently animal health. Farmers' decision making and practices regarding antimicrobials can be determined by various antecedent confounding variables, which are external to the farm (like housing conditions, sanitation of the animals) and by personal variables (like farmer's age, education) (Willock *et al.*, 1999). In this context, internal variables may also have an effect on livestock rearers antimicrobial use, which includes the farmers outcome attitudes towards antimicrobials, subjective beliefs about antimicrobial resistance, perceived behavioral control over the use of antimicrobials in farming (Willock *et al.*, 1999).

In order to develop an effective intervention that reduces the use of antibiotics among farmers, it is important to examine in detail the antecedent and internal variables related to antibiotic usage. Since antibiotic resistance is a serious problem that affects both animal and human health management (EFSA and ECDC, 2013), policy makers are in aim to reduce the antibiotic usage in animal husbandry. A successful reduction on antimicrobial use depends on whether farmers are willing to apply alternative measures to reduce disease incidents and injuries like biosecurity measures and financial compensation for adopting

safety and improved livestock rearing practices could stimulate farmers' willingness to apply such alternative methods (Kane *et al.*, 2004). The prescribing behavior of veterinary medicines largely depends on the experience and professional judgement of the veterinarians and paravets. A study by Grave *et al.*, (2010) on antimicrobial usage pattern in 10 European countries was starkly contrasting. They reported that a number of factors were involved at different levels and involvement of stakeholders which is beyond the simple knowledge of animal species distribution. An interesting study carried out independently by De Briyne *et al.* (2013) and Gibbons *et al.* (2012) which can be summarized as veterinary doctor's decision for choosing the antimicrobial for the disease can be affected by farmers socio-economic conditions, price of the antimicrobial, ease of administration and withdrawal period. It has been found that once an antimicrobial is prescribed to the livestock farmer, very few reports on how antimicrobials recommendations are taken into consideration by the farmer to reduce the dependence on antibiotics. Friedman *et al.* (2007) has highlighted in their study lack of reports on farmers knowledge and attitudes towards antimicrobial use in livestock. It has been found that farmers mostly rely on their own farming experience or peer farmer networks rather than scientific evidence/proof to decide which treatment method and antimicrobials to be adopted.

Conclusion

In the present scenario, AMR is a multiple sectoral threat at global level and swift attention needs to be carried out in a developing country like India. Attention has turned towards prudent use of antimicrobials with respect to the prescribed guidelines as stated in the treatment of livestock. While the review of literature was carried out, the researchers have identified limited data on the pattern of antimicrobial use that hindered in designing measures to tackle this growing problem. The main stakeholders involved in animal husbandry and having considerable influence on farmers decisions for animal health management needs to be identified. The stakeholders can serve as the main driving force towards judicious use of antimicrobials in animals. The approaches veterinary doctors follow in disease identification and treatment pattern and the path livestock farmers carry out the instructions in case of treating ailments is of great importance. Farmers most likely to reduce antibiotic use were those who derived a higher than average share of farm income from the dairy enterprise and were planning to continue operating a profitable dairy enterprise for the foreseeable future. Scientists and field level veterinarians and other stakeholders have held the belief that if treatment guidelines are undertaken correctly by farmers, reductions in use of antibiotics could yield financial benefits to them, primarily in the form of reduced costs, without affecting the animal welfare of their dairy cows or their herds' milk output.

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