Country Status Report
Regional Consultation Meeting
on
Preparedness of Member Countries for Addressing
Anti -Microbial Resistance (AMR) in Livestock

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Introduction

According to the World Census of Agriculture 2020 (WCA 2020), raising and breeding livestock is an economic activity that is a part of agricultural activities in a broad sense. The term "livestock" refers to "all animals, birds and insects kept or reared by the agricultural holdings mainly for agricultural purposes. This includes cattle, buffaloes, horses and other equine animals, sheep, goats and pigs, as well as poultry, bees, silkworms etc." Domestic animals, such as cats and dogs, are excluded unless they are being raised for food or other agricultural purposes.

In many developing countries, livestock production contributes to approximately one-third of the value added from agriculture (FAOSTAT, 2013). In Bhutan, Livestock play a crucial role in Bhutanese farming with a diverse range of animals being raised by farmers, including both bovine and other species and continues to play a significant role in enhancing food self-sufficiency and nutrition security (IALC 2023). Livestock production contributes to nutrition security by providing a source of protein through meat, dairy, and other animal products. It plays an important role in reducing rural poverty and enhancing rural livelihood through income generation opportunities for rural communities engaged in livestock farming.

Total population of ruminants is 3,30,774 and 8,59,077 non-ruminants (IALC 2023). Among the ruminants, cattle was the predominantly reared species with 2,22,597 (67.2%) heads while, Mithun (*Bos frontalis*) was the least (0.08%) bovine kept for production. Small ruminants (sheep and goat) were mostly reared by southern Bhutanese with a total population of 9,411 and 60,798 respectively. Highest population of yak (9,746) is primarily found in Thimphu district mostly owned by the highlanders of Naro, Dagala and Lingzhi playing an important role in the socio-economic lives of the people and national security. On the contrary, buffalo were the least livestock with a population of only 422 mostly seen in the southern districts of the country.

On the other hand, non-ruminants had a total population of 39,742 which included horse (74.5%) and pig (25.5%). Out of 10,117 equines, 26.6 % is distributed in Gasa district. These animals were mostly used for transportation especially by the people of Laya and Lunana which

lie 3820 and 3600 meters above sea level. In contrast to other livestock species, the poultry population dominated with 8,19,335 (20.2%) birds being concentrated in Sarpang district. As per annual Livestock statistics, the pet population (cat and dog) stands at 34,644 and 29,842 respectively. Over the years, dog population including free-roaming has drastically reduced as a result of National Accelerated Dog Population Management and Rabies Control Program NADPM and RCP) under the command of His Majesty the King with an objective to achieve 100% free roaming dog sterilization, ensure responsible pet ownership through digital identification and achieve the global goal of "0 by 30" – zero human death due to dog-mediated rabies by 2030 through intensified vaccination campaign. A total of 61,680 were sterilized of which 56,251 (91%) were stray dogs.

In-terms of Livestock products statistic, milk production stands at 43,828.51 metric tons (MT) followed by meat (Pork, beef, chevon, mutton, chicken and fish) 4,668.49MT, egg 17,24,82,491 pieces, butter and cheese 1,727.46 MT and 2,326.27 MT respectively (IALC 2023). However, the Department of Livestock has projected to produce an additional 1845 MT of pork, 250 MT of fish, 174 million eggs and 73,984 MT of milk in the 13th five year plan.

Bhutan is an agrarian country providing livelihoods to 49% of its total population from agriculture. The majority of the farming community in the country practices self-sustaining and sustainable farming owing to the small, scattered, and marginal landholdings. The contribution towards GDP from the RNR sector (Agriculture, Livestock, and Forestry) has increased to 19.23% in 2020 from 14.78% in 2010.

Initiatives for Women Empowerment through Livestock Platform

Dairy farming is instrumental in bringing about socio-economic transformation of rural people in developing countries. In Bhutan, dairy farming forms an integral part of the farming sector for rural development as it plays a major role in poverty reduction, food security enhancement, and income as well as employment generation. Bhutanese dairy farmers are now gradually transforming from subsistence farming to a market-oriented production system by rearing high-yielding crossbred animals and adopting better husbandry practices. Over the years dairy production has thus gained steady momentum, which is a positive sign of dairy development in the country.

A nuanced understanding of gender dynamics in dairy farming is essential for formulating inclusive policies that support sustainable development in the sector. By addressing these dynamics, governments, NGOs, and other stakeholders can contribute to improved livelihoods and enhanced productivity throughout the dairy value chain (Kuma et al 2006). Understanding and addressing gender relations in dairy farming and agriculture more broadly is essential for promoting equitable and sustainable development. Policies and interventions that aim to empower women, promote gender equality, and address barriers to participation can lead to improved household security, enhanced family well-being, and increased productivity within the agricultural sector (Patel et al2016). Understanding the different roles that each family member plays; what and how much contribution they make, and access to and control over resources and decision-making powers within the households and communities, shall form the

basis for addressing inequalities in any policy or program (Cheizom & Choden 2014). Throughout recorded history, the role of women in farming has been multidimensional. Women are involved both as farmers and farm labour that play a significant role in enhancing the productivity, profitability and sustainability of the farm (Yasmin & Ikemoto, 2015),in addition to performing household chores and bringing-up children.

Challenges

Women constitute most of the agricultural labour force as farmers, retailers, or extension officers. Yet, economic and legal barriers hamper women from maximizing opportunities in the agri-food system. Many females in rural areas are subsistence farmers, responsible for many unpaid duties, and have limited access to formal employment (Bhutan labour Market Assessment 2024). In addition, the latest edition of the "Women, Business, and the Law report" (World Bank 2024) highlights various legal barriers impeding the economic empowerment and decision-making of female farmers in Bhutan. Female agri-food entrepreneurs often have no regular wages as they primarily work small scale food production and contribute to the farm as family members.

The recent outmigration of young males from Bhutan's rural areas compounds female's burden of unpaid works and reinforce traditional gender roles. Female agro-entrepreneurs face unequal access to financial and technical resources to cope with the ever-growing challenges caused by climate change and human-wildlife conflicts. In addition, Bhutanese female entrepreneurs face numerous legal constraints hindering their economic potentials without land ownership rights, they cannot access agricultural financing, lack access to affordable quality childcare and lacks access to capacity building and skill development tailored to women in the agri-food system (World Bank 2024).

Initiatives unlocking potential for women in Agri-food System

- The Bhutan-Based Rural Entrepreneurship Project provided business skill training and small grants to agro-entrepreneurs—most of whom are women.
- The food Security and Agricultural Productivity Project subsidizes woman-friendly agricultural technologies (power tillers) and promotes female leadership in agricultural marketing groups, and champions females as Community Response Persons for improved dietary behaviour.
- Bhutan's Jobs and Economic Opportunities Project invests in women's education and skill development in the agri-food system. It supports them through training and childcare initiatives to uplift them from low-productivity agricultural roles to higher-value, market driven position.
- The Bhutan Human capital Recovery and resilience Project supports Early Childhood Care and Development and mainstreams gender in Bhutan's Technical and Vocational Education and Training Sector Development Program.

Table 1. Common Antimicrobials Imported and used in Livestock Sector (FY 2023-24)

S. No	Type	Generic Name	Strength	Presentation	Quantity Imported (FY 2023-24)
1	**Sulfonamides**	Trimethoprim Bolus	400 mg bolus	4 Boli/strip	6374
		Trimethoprim Powder	80mg/gm	100 gm Sachet	11490
2	**Diaminopyramidine**	Sulphadimidine Injection	33.33%	100 ml vial	1392
		Sulphadiazine Bolus	2 gm	4 Boli/strip	6374
		Sulphanilamide Powder	400mg/gm	100 gm Sachet	11490
		Enrofloxacin injection	100mg/ml	30 ml vial	2284
3	**Quinolones**	Enrofloxacin Tablet	150 mg tab	10 tab/strip	3501
		Ciprofloxacin ear/eye drops	0.30%	5 ml vial	17255
		Amoxycillin Trihydrate Bolus	1.5 gm	2 Boli/strip	10554
4	**Beta Lactum**	Ampicillin + Cloxacillin Injection	1 gm + 1gm	2 gm vial	4871
		Procaine Penicillin G injection	20 lakhs IU	2.5 gm	3282
		Benzathine Penicillin Injection	24 lakhs IU	24 lakhs IU vial	5064
		Cephalexin Bolus	1.5gm	2 Boli/strip	3459
		Gentamicin Injection	40 mg/ml	30ml vial	4336
5	**Aminoglycosides**	Streptomycin Injection	2.5g	2.5 gm vial	3282
		Oxytetracycline LA Injection	200 mg/ml	30 ml vial	5283

6	**Tetracyclines**	Oxytetracycline SA	50 mg/ml	50 ml vial	1675
		Tetracycline Hydrochloride W/S	5gm/100gm	100gm sachet	14939
		Doxycycline Hyclate Tablet	50 mg tablet	100 tab/jar	503
7	**Nitroimidazoles**	Metronidazole Injection	500 mg/ml	100 ml bottle	7997
8	**Imidazole derivatives**	Ketoconazole Tablet	200mg	10 tabs/strip	1963
		Clotrimazole Ointment	1%	15 gm tube	3230
9	**Cephalosporins**	Ceftriaxone	500mg	500 mg/vial	1684
		Cefotaxime	1gm	1gm vial	6737
		Cefoperazone Intramammary	250 mg	10 ml tube	8344
10	**Amphenicol**	Chloramphenicol	20mg	100 caps per jar	3928

Table 2. Common anthelminthic and anti-protozoal imported and used in Livestock Sector

S. No	**Type**	**Generic Name**	**Strength**	**Presentation**	**Quantity Imported (FY 2023-24)**
1	**Anthelminthic**	Albedazole	150 mg	10 tabs/strip	7910
		Livamisole+Oxyclozanide Suspension	Levamisole 3.0% + Oxyclozanide 6% W/V	1Liter jar	2657
		Triclabendazole bolus	900 mg bolus	5 boli/strip	5204
		Fenbendazole bolus	1.5gm bolus	5 boli/strip	5703
		Piperazine citrate solution	40% solution	450ml bottle	2369

		Tetramisole powder	30% tetramisole	500 gm jar	357
		Ivermectin Inj.	1% W/V injectable liquid	10 ml vial	2733
		Praziquantel + Pyrantel pomoate + Febental	50mg+144mg+150mg	10 tab/strip	3118
2	**Anti-Protozoal**	Diaminazine aceturate Inj.	Diminazine 70mg + Phenazone 375mg	30 ml vial	314
		Diaveridine + S'Quinoxaline powder	3.3 % W/W, 18.7% W/W	100 gm sachet	6105
		Amprolium+Sulfaquinoxaline powder	Amprolium 100g+Sulfaquinoxaline 100g+Vitamin K3 2g	100 gm sachet	4584

Status of National Action Plan on AMR (2018-2022)

Bhutan developed a National Action Plan (NAP) on Antimicrobial Resistance (2018 – 2022) approved by the Ministry of Health and endorsed by the Cabinet. The NAP features an integrated One Health approach to address AMR and the transmission of drug-resistant pathogens between humans, animals, and the environment. NAP ensures that various sectors—human health, animal health, agriculture, environment, and public work together coherently through one health approach. This engagement fosters ownership and commitment to tackling AMR at all levels. Further it provides a structured framework for implementing specific actions aimed at combating AMR by promoting responsible antibiotic use, improving surveillance of resistant infections, enhancing infection prevention and control measures, and supporting research and development of new antibiotics and alternative treatments. In addition, it provides a mechanism for monitoring progress and evaluating the impact of interventions fosters international collaboration and information sharing, given the global nature of AMR. Public awareness and education is one the key components of NAP to raise public awareness about AMR and promote behaviour changes that reduce the unnecessary use of antibiotics. Educating both healthcare providers and the general public is key to achieving sustainable reductions in antibiotic resistance. The activities of the AMR program listed under the NAP were achieved through collaboration with the relevant stakeholders- animal health, human health, Bhutan Food and Drug Regulatory Authority (BFDA) funded by the Fleming fund country grant. To sustain the national AMR surveillance system, the Royal Government of Bhutan has incorporated tackling AMR into its national budget. This will include the upkeep of the Fleming Fund country grant-procured laboratory equipment by on-site trained biomedical engineers, and the replacement of consumables and reagents for routinely used equipment at surveillance sites to maintain in-country professional resources.

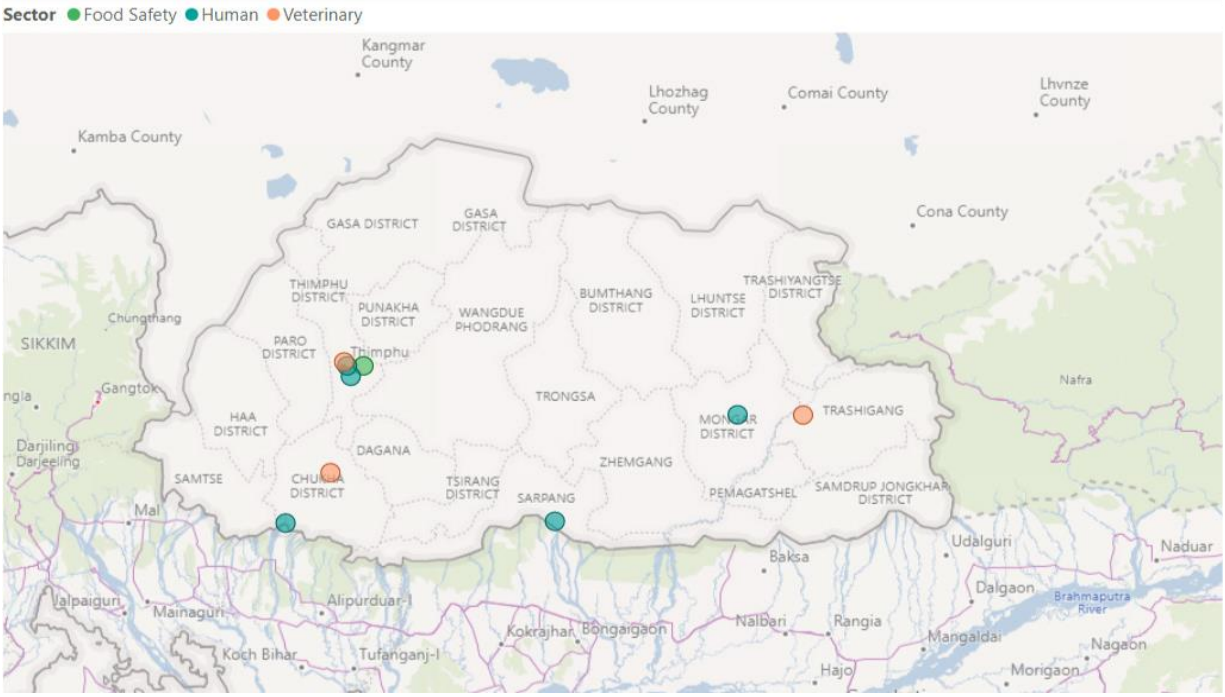


Fig 1. Fleming fund supported laboratories across Bhutan

Achievements in Fleming Fund Country Grant phase I

- AMR surveillance reference laboratories in four surveillance sites were equipped and trained to perform antimicrobial susceptibility tests (AST).
- AMR surveillance sites renovated advanced laboratory equipment at National Centre for Animal Health (NCAH) to support the country's animal health system.
- Establishment of robust governance and reporting systems in animal health laboratories.
- AMR data surveillance protocols updated, validated, endorsed, and used by respective laboratories.
- One health collaboration increased through activities such as sheep blood collection and maintenance for AMR testing.
- Conducted AMU surveys in animal health facilities and farms for clinical engagement, formulating AMU guidelines, and influencing policy.
- Digital software and applications updated and upgraded to incorporate AMU guidelines in animal health.
- Reference laboratories participate in external quality assurance (EQA) assessment and provide national EQA assessment to surveillance sites.
- 1,060 data samples collected for active AMR surveillance conducted in commercial farms. Data generated informed technical committees, community of practice and policy makers on AMR status in the poultry sector in Bhutan.
- Strengthened One Health coordination mechanism and governance by supporting High-Level Inter-ministerial Committee for One Health (IMCOH),National AMR Technical Committee (NATC) and Technical Working Group (TWG).
- Fellowship scheme for professional cohort I- AMR/AMU/AMC surveillance and AMR laboratory fellows in animal health (Doherty institute, Melbourne university).

Fig 2. Sample collection, culture preparation and bacterial growth

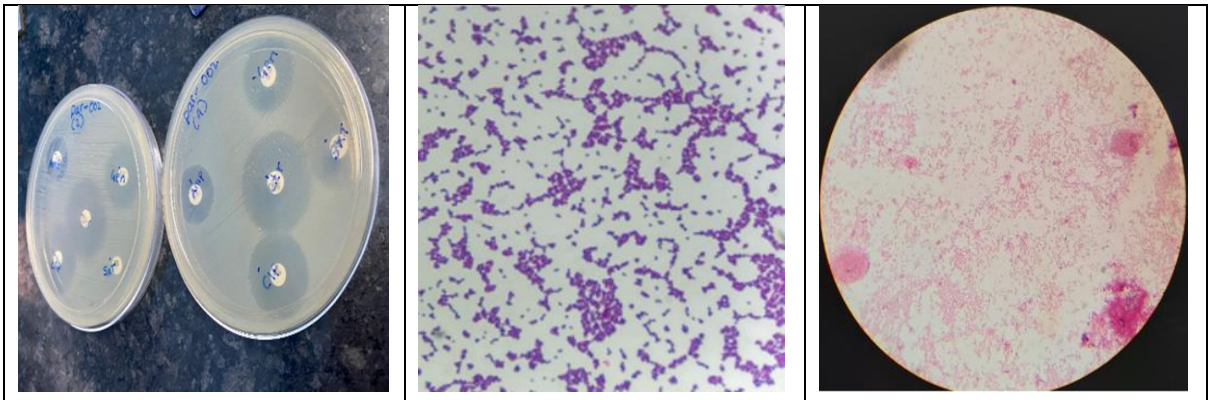


Fig 3. AST and bacterial identification

Fig 4. Training of laboratory technicians

National Action Plan on AMR (2024-2028)

NAP document was drafted in November 2023 and in the state of review and finalization. The second phase broadly has four major objectives with 28 milestones to be achieved with the support from Fleming fund country grant phase II and the work plan has been finalized during the inception workshop in July 2024.

Objectives

1. To establish a governance structure to spearhead the AMR activities.
2. To promote rational use of antimicrobial agents at all levels of healthcare and veterinary settings.
3. To institute surveillance and monitoring systems on AMR and antimicrobials use.
4. To create and promote awareness on AMR through educational and public campaigns.

Overuse/ misuse of Antimicrobials in livestock

Over use and misuse of antibiotics are the first risk factors for the development of against antibiotics. In low- and middle-income countries (LMIC), antibiotics are less regulated, and there is limited reporting on the extent of their use. In contrast, high-income countries, intense control and regulation have resulted in a reduction of antibiotic prescription and improved

stewardship. However, Villanueva et al., (2021) reported positive features of veterinary antimicrobial stewardship in Bhutan. The study suggests that further improvements of antibiotic stewardship can be achieved through standardisation of antibiotic prescription to some species, a revision of the guidelines toward reducing the prescription of antibiotics of high relevance for human medicine, and by including details of clinical investigation, use of tests, and treatment outcomes in veterinary consultation records.

According to the World Organization for Animal Health (OIE), most LMIC members lack mechanisms to accurately estimate the use of antibiotics in animals, which limits their capacity to report type, dose, route, and purpose of antibiotic dispensing to animals (Moulin et al., 2016). In contrast, Bhutan uses software digital apps (Drukmed) serving as a pocket drug index to calculate the dose and give assess to antibiotic guidelines, while G2C software regulates the procurement and distribution of medicines across the country. In addition, online veterinary information system (VIS) takes care of the daily use of antimicrobials in the animal health facilities. Furthermore, there is a mandatory physical monitoring of medicine storage and usage in the field by the Drug Regulatory Authority (DRA). Villanueva et al., (2021) further reported a consistent use of antimicrobials (84%) in bovines and canines, whereas its use in poultry is higher in livestock extension centres (LECs) with an estimated 75%. The study also observed that Accounting for all antibiotic prescription to the top species, between 45% (ruminants) and 75% (avian) corresponded to access agents, between 5% and up to 25% to watch agents, and up to 20% of the antibiotics prescribed had "undefined" classification.

Impact and challenges

- Inadequate professional competence animal health workers might worsen the complications associated antimicrobial resistance.

- Easily accessibility of the strongest antibiotics without prescription which may lead to increased incidences of self-medication.
- Emergence of drug-resistant bacteria, which are completely resistant to available antibiotics.
- Development of antibiotic resistance, causing potentially serious effects on human health.
- Financial constraints to implement the NAP and its sustainability.
- Lack of advocacy and education on AMR.
- Lack of technical professionals to carry out active surveillance, systemic reporting and research to influence policy makers.
- Irrational use of antimicrobials without proper diagnosis irrespective of case type and poor compliance to treatment guidelines.
- Guidelines adapted from the international guidelines and do not incorporate the antimicrobial resistance pattern in the country (NAP 2018-2022).
- No clinical treatment pathways for infectious diseases both in human and animal health.

- Routine prescription monitoring on antimicrobial use is done at few animal health centres but it is not systematic and monitoring is weak (NAP 2018-2022).
- Inadequate interdisciplinary coordination and lack of clinical auditing in ensuring rational use of antimicrobials.
- Data are not analysed and used for influencing prescribing behaviour.

Future strategies

- Establishment of High Level Inter-ministerial Committee for One Health (IMCOH) for tackling AMR issues.

- Guideline needs to be reviewed and updated based on the antimicrobial resistance pattern and compliance to it should be promoted through institution of audit mechanism and regular awareness programs
- Development and incorporation of AMR modules into pre-service curriculum.
- Develop Infection Prevention Control guidelines and standard operating procedures (SOPs) for Animal Health.
- Antimicrobial stewardship (monitoring and reporting of antimicrobial use).
- Strengthen Microbiology testing facilities at all major veterinary hospitals/Laboratories.
- Strengthen AMR residual testing facilities.
- Monitor antimicrobial consumption in the animal health facilities.
- Develop national strategy for awareness-raising, advocacy, risk communication and other behaviour change interventions to facilitate more impactful awareness and engagement initiatives.
- Prioritize and conduct research in food related to AMR.
- Develop mechanisms to promote coordination within the disciplines.
- There are no regulatory provisions on control of non-therapeutic use of antimicrobials in animals and therefore, there is a need to include such provisions under the medicines rules and regulations.

Activities/research initiatives by ministry/Department in collaboration with international organizations to tackle the AMR challenge and latest outcome of focused research/ programmes

NAP 2017 stated that there is no enabling environment for research on antimicrobial use. The support to carry out research is inadequate both in terms of financial and human resources. Planning is not evidence based and available evidence is not utilized for planning activities related to antimicrobials. As such, there is limited scope and incentive for research. However, Research should be encouraged and accorded priority. In order to address effective intervention at the local level, regular operational research should be planned and carried out. One of the objectives of the NAP 2017 was to promote and prioritize research on AMR and need-based research shall be promoted to generate evidence for clinical practice, rational use and support policy

and planning through the Fleming fund country grant in collaboration with relevant stakeholders and international organizations. Therefore, few research has been carried out in various fields of AMR with the following outcomes:

1. **Antibiotic Prescription in Veterinary Consultations in Bhutan: A Retrospective Cross-Sectional Study** (Villanueva et al., 2021)**.**

Outcome:

The results suggested that the Bhutanese veterinary service practices a conservative prescription of antibiotics in terms of frequency and type as per the AWaRe index, which is a positive feature of antimicrobial stewardship. Further, Bhutanese approach to antibiotic prescription, which is managed by a hierarchical veterinary service and harmonised through standard treatment guidelines, may serve as an example, and could help in guiding veterinary antimicrobial stewardship processes in other low- and middle-income countries.

2. **Antimicrobial Consumption in the Livestock Sector in Bhutan: Volumes, Values, Rates, and Trends for the Period 2017–2021**(Gurung et. al., 2023).

Outcome:

The volume of antimicrobial consumption in livestock in Bhutan are considerably lower comparing to other countries in the South Asian region demonstrating that imposition of appropriate regulation of importation and use of antimicrobials in animal health, coupled with development of local guidelines for appropriate use, have the potential to achieve major reductions in antimicrobial use in animal health across Asia. Data are currently not available to assess the impact that these differences in antimicrobial consumption have had on patterns of antimicrobial resistance in bacteria in livestock in Bhutan. However, this study has provided a basis for assessment of the impact of strong antimicrobial governance in animal health in future studies on AMR in pathogens of importance in humans and livestock.

3. **Knowledge, attitude, and practice on antibiotic use and antibiotic resistance among the veterinarians and para-veterinarians in Bhutan** (Wangmo et al., 2021).

Outcome:

The study identified that most animal health workers in Bhutan had poor knowledge on anti-biotics use and AMR. The choice of antibiotic was influenced by their availability in the centre. This could lead to inappropriate use of antibiotics. Hence interventions are needed to make the required antibiotics available based on the sensitivity data and disease epidemiology. Most importantly, regular awareness education on antibiotics and AMR in the form of refresher course/training and workshops must be provided to the animal health workers in the country.

4. **Antimicrobial resistance surveillance in healthy chicken against priority bacterial pathogens *(Salmonella, Enterococcus, Campylobacter and E. coli) in Bhutan***

The study was conducted during the first phase of Fleming Fund country grant. The results are yet to be published.

5. **Knowledge, attitude, practice about antimicrobial resistance and antimicrobial use among poultry farmers in Bhutan**

This study was undertaken through the Fleming Fund support during the first country grant. This study was aimed at understanding the knowledge, attitudes and practices among the poultry farmers in Bhutan with regards to the antimicrobial use and antimicrobial resistance. Such study has not been undertaken previously and therefore, would provide evidence to guide policy interventions in mitigating AMU and AMR in the poultry sector in Bhutan. The results of the study are yet to be published.

6. **Customization of Laboratory information system (LIMS)**

With the help of the Fleming fund project, the laboratory information system was customized to provide a robust data entry and reporting system of microbiology results in the animal health sector in Bhutan.

7. **Customization of Veterinary information system (VIS)**

The veterinary information system (VIS) enables veterinarians and para-veterinary professionals to record prescription details in the VIS database for efficient recording as well as reporting of veterinary prescription records. This database effectively replaces the paper based records in Bhutan.

8. **Mobile app under One health approach**

A mobile app called DRUKMED was developed as a one health approach in Bhutan with the help of Fleming Fund country grant-I. It contains human health, animal health and traditional medicine references and guidelines to promote effective use of drug formulary and relevant guidelines across these health sectors.

9. **Antimicrobial stewardship policy document**

A draft antimicrobial stewardship policy document has been developed during the first phase of the Fleming fund project. This document is aimed at instituting an antimicrobial stewardship program in Animal health sector in Bhutan which is currently lacking.

10. **Antimicrobial use guideline for livestock in Bhutan**

A draft antimicrobial use guideline for livestock species (cattle, horse, pig, poultry, dogs and cats) have been developed to guide the veterinary practitioners in judicious use of antimicrobials in Bhutan.

Alternatives to antimicrobials currently in used by livestock sector with regard to growth or disease management

There is a critical need to develop innovative antimicrobials that provide alternatives to conventional antibiotics and that are refractory to resistance development. On the other hand, eliminating the use of antibiotics for animal production may have adverse consequences on the animal's health, production and welfare. However, Seal et al., (2023) found advanced research tools such as metagenomics and other genome-enabled technologies can provide insight into the ecology of the gut microbiome, host–pathogen interactions, immune development, nutrition and health. This will further provide new opportunities for developing alternative strategies to enhance the production and health of livestock, poultry and fish. Wang et al., (2016) studied the antimicrobial peptides (AMPs) as potential alternatives to antibiotics in the food animal industry reported the beneficial effects of AMs on growth performance, nutrient digestibility, intestinal morphology and gut microbiota in pigs and broilers. In addition these products have broad-spectrum activity against bacteria, fungi, and viruses but also have the ability to bypass the common resistance mechanisms. Although many studies have clearly demonstrated the potential of probiotics to positively affect animal health and inhibit pathogens, experimental evidence suggests that probiotics' successes are modest, conditional, strain-dependent, and transient (Cameron & McAllister, 2019).

In Bhutan, although high end research is not being carried out to explore effective alternative products to replace the antimicrobials or reduce their use in animal health and production people in olden days use red mud, spider webs and urine as an antiseptic paste on wounds. The principle behind this might be to arrest bleeding by sealing the wound but combination of these might have antiseptic properties promoting wound healing.

Table 3. Common alternative medicines used in Bhutan

Category	Generic Name	Composition
GASTROINTESTINAL DRUG	Bobirum Bolus	Antimony Potassium Tartrate 2 gram,ferrous sulphate 2 gram,Copper sulphate 50 mg and Cobalt chloride 100 mg
	Rumenotoric/stomachic powder	Hurbal
REPRODUCTIVE DRUGS (I/UTERINE PREPARATION)	Anti-bloat powder	Herbal
	Liver tonic powder	Herbal

	Uterinetonic powder	Herbal
	Povidone Iodine	Chemical

MINERALS/VITAMINS	Mineral mixture powder	Calcium, Phosphorous, Magenese, sodium cholride, Magnesium, Zinc, Iodine,Cobalt and Copper
	Yeast extract	Ferrous sulphate,Copper sulphate,Vit B,Lactic acid base bolus, Com
	B complex tablets and injections	-
EXPECTORANTS	Anti-tussive/anticough powder	Herbal
ANTISEPTICS	Maggoticidal spray	Herbal
	Gammabenzene ointment	Herbal
	Benzonic acid powder	Chemical
	Potassium permanganate	Chemical

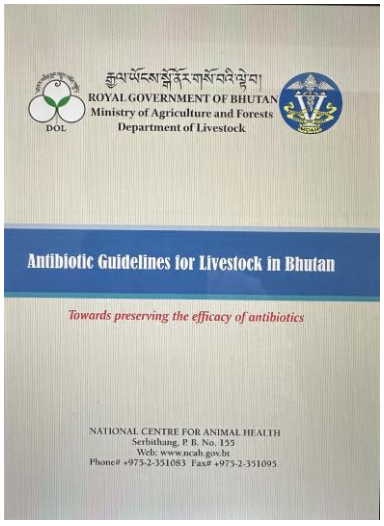
Best practices for AMR challenge in food producing animals

Extensive antibiotic use on farms drives the emergence of antibiotic-resistant organisms in food-producing animals, which can be transmitted to people and the environment. Antibiotic stewardship in food production has been associated with decreased rates of resistance in both animals and humans, without reducing farm productivity by banning use of antibiotics for disease prevention, benchmarking antibiotic utilization, and setting national reduction targets (Patel et al., 2020). Similarly in Bhutan, the department of livestock in collaboration with the BFDA work together to ensure best practices in semi-commercial and commercial including government farms. There are policies, guidelines and standard operating procedures (SOPs) in place to secure and regulate the farms. These measures primarily focus on reducing incursion of diseases in the first place by mandatory quarantine of imported animals.

Figure 2. Launching of Bhutan Biosecurity and Food Safety Strategy and Action Plan (2021-2028)

Documents regulating good farm biosecurity

- Antibiotic guidelines for livestock 2016 (restriction on use of antimicrobials in animal feeds, withdrawal period)
- Standard treatment guidelines 2017
- National Veterinary drug formulary 2019
- In-country Livestock biosecurity guidelines 2015
- Infection prevention control (IPC) guidelines for Veterinary Hospitals (to be reviewed and finalized)
- Food Act of Bhutan 2005
- Food Rules & Regulations 2017
- Bhutan Biosecurity and Food Safety Strategy
- Action Plan (2021-2028)



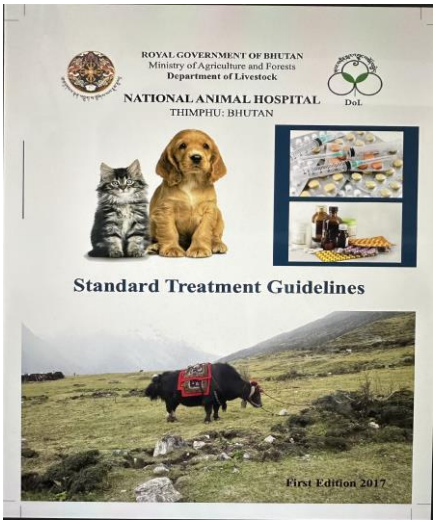


Figure 3. Guidelines

The Strategy and Action Plan will help the country to address future biosecurity challenges in a better way. It outlines five prioritised goals: Invest in effective prevention and preparedness, adopt evidence-based best practices, create knowledge-sharing systems, enhance collaboration and make the actions more sustainable to build resilience.

Awareness to address AMR challenge

- Participation during World antimicrobial awareness week (WAAW) annually - one health advocacy meets.
- Participation in BBS (Local news channel) panel discussion
- All the animal health facilities observe WAAW annually (November).
- Awareness posters and charts in veterinary hospitals.

Figure 4. Promoting awareness on AMR during the WAAW, 2020

Recommendation on research and development, policy, and extension Services for addressing AMR in livestock

Surveillance is one of the cornerstones of infectious disease management, however, this has been often ignored and remained under-resourced in the fight against AMR. Surveillance and reporting of antimicrobial resistance and antibiotic usage have become a global health priority. Through the support from FF the surveillance in AMR has been strengthened in livestock. The capacity developed through the programme can be applied to conducting active and passive AMR surveillance in all livestock species. The implementation of the surveillance program and information generated thereof will contribute to One Health approach to AMR surveillance in the country. To clearly understand the pattern of antimicrobial resistance and generate a baseline information, continuous surveillance will be required. Antimicrobial stewardship must be strengthened to tackle AMR issues in veterinary hospitals across the country and continuous monitoring of antimicrobial usage in the field. The existing data collection tools (VIS, G2C, LIMS) must be updated and made user friendly to manage wide range of data information.

Conclusion

Bhutan, a small landlocked nation with a population of approximately 8 million, has over 60% of its populace residing in rural areas, relying heavily on agriculture and livestock farming for their livelihoods, ranging from backyard to semi-commercial operations. As of the Livestock Census 2021, the total livestock population, including dogs and cats, stood at 1,914,096. The agriculture and livestock sectors contributed 19.23% to the GDP in 2020.

The first National Action Plan (NAP) on Antimicrobial Resistance (AMR), launched on November 17, 2017, aimed to foster a coherent multi-sectoral approach in combating AMR, supported by funding from the Fleming Fund. Phase I of this initiative focused on strengthening reference laboratories for animal health to conduct active AMR surveillance in poultry. Additionally, significant efforts were made in human resource capacity building through professional training, alongside upgrades to data collection and management systems to ensure the accuracy and authenticity of reporting.

Looking ahead, the NAP on AMR for 2024-2028 has been formulated with four primary objectives, supported by Phase II of the Fleming Fund. A pivotal component of this phase involves establishing antimicrobial stewardship at the National Veterinary Hospital. This initiative aims to coordinate, regulate, and monitor antimicrobial consumption across animal health facilities, thereby enhancing control measures against AMR.

This strategic approach underscores Bhutan's commitment to sustainable agricultural and livestock practices while addressing the critical issue of antimicrobial resistance through structured, collaborative efforts supported by international partnerships.

Way forward

To effectively implement all AMR activities outlined in the NAP 2024-2028, we will collaborate closely with relevant stakeholders, including international organizations supported by the Fleming Fund. Our primary focus will be on generating research-based information to influence policy decisions. We aim to lead animal health workers in the forefront of the fight against AMR and advocate for public awareness. To ensure the sustainability of our AMR program, our department is committed to working tirelessly to persuade the government through the publication of our research findings.

Reference

Wangmo, R., Om, K., Choden, P., Acharya, S., Dorji, N., Gyeltshen, K., ... & Hossain, M. B. (2023). Climate-Smart Agriculture Technologies and Practices in Bhutan. SAARC Agriculture Centre, SAARC, Dhaka, Bangladesh, 56p.

Kuma, B., Feyissa, F., & Nesha, K. (2006). Gender Based Analysis of Livestock Production Systems at Kuyu wereda in North Shao zone, Ethiopia. *ESAP Proceedings*, 88.

Patel, S. J., M. D. Patel, J. H. Patel, A. S. Patel, and R. N. Gelani. "Role of women gender in livestock sector: a review." (2016): 92-96.

Cheizom, P., & Choden, T. (2014). Role of Rural Women in Sanitation and Hygiene: A Gender Study from Bhutan. *SNV: Thimphu, Bhutan*.

Yasmin, S., & Ikemoto, Y. (2015). Women's participation in small-scale dairy farming for poverty reduction in Bangladesh. *American International Journal of Social Science*, *4*(5), 21-33.

Alaref, J., Martinoty, L., Viollaz, M., Bartl, E., Leite, P., & Ndip, A. E. (2024). Bhutan Labor Market Assessment Report.

World Bank. (2024). *Women, Business and the Law 2024*. The World Bank.

Villanueva-Cabezas, J. P., Rinzin, K., Dorjee, S., Tshewang, P., Namgyel, U., Sharma, P. M., ... & McVernon, J. (2021). Antibiotic Prescription in Veterinary Consultations in Bhutan: A Retrospective Cross-Sectional Study. *Frontiers in Veterinary Science*, *8*, 641488.

Moulin, G., Gochez, D., Diaz, F., Szabo, M., Lasley, J., & Erlacher-Vindel, E. (2016). Analyse des reponses au questionnaire de l'OIE sur l'utilisation des agents antimicrobielns chez les animaux en 2015. *Bulletin de l'OIE*, (3), 82-85.

National Action Plan on AMR 2018-2022. Royal government of Bhutan.

Gurung, R. B., Zangmo, K. P., Gilkerson, J. R., Browning, G. F., Ferdinand, A. S., & Coppo, M. J. (2023). Antimicrobial Consumption in the Livestock Sector in Bhutan: Volumes, Values, Rates, and Trends for the Period 2017–2021. *Antibiotics*, *12*(2), 411.

Wangmo, K., Dorji, T., Pokhrel, N., Dorji, T., Dorji, J., & Tenzin, T. (2021). Knowledge, attitude, and practice on antibiotic use and antibiotic resistance among the veterinarians and para-veterinarians in Bhutan. *PloS one*, *16*(5), e0251327.

Seal, B. S., Lillehoj, H. S., Donovan, D. M., & Gay, C. G. (2013). Alternatives to antibiotics: a symposium on the challenges and solutions for animal production. *Animal Health Research Reviews*, *14*(1), 78-87.

Wang, S., Zeng, X., Yang, Q., & Qiao, S. (2016). Antimicrobial peptides as potential alternatives to antibiotics in food animal industry. *International journal of molecular sciences*, *17*(5), 603.

Cameron, A., & McAllister, T. A. (2019). Could probiotics be the panacea alternative to the use of antimicrobials in livestock diets?. *Beneficial microbes*, *10*(7), 773-799.

Patel, S. J., Wellington, M., Shah, R. M., & Ferreira, M. J. (2020). Antibiotic stewardship in food-producing animals: challenges, progress, and opportunities. *Clinical therapeutics*, *42*(9), 1649-1658.