Medically rational use of antibiotics to reduce resistance and support effective animal production in low- and middle-income countries

Ulf Magnusson[1]*

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Livestock, resistance to antibiotics, biosecurity, disease management, hygiene, Africa, Asia

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Summary

Background: Antibiotic resistance is a threat to human and animal health. The problem is exacerbated by the fact that similar antimicrobial drugs are used to treat both animals and humans. The global livestock sector is the largest consumer of antibiotics in the world. Since the use of antibiotics drives the emergence of resistance, it is crucial to reduce their use in the livestock sector, not only for the sake of animal health, but for public health as well. To tackle the issue of antibiotic resistance, countries are setting up regulations. These include banning the use of antibiotics as feed additives for growth promotion, making veterinary prescription a prerequisite for sale and restricting the use of antibiotics of critical importance for human medicine. ***Aim:*** To share our practical experience and summarize data from our studies on the use of antibiotics relating to animal management in South East Asia, East Africa and Northern Europe. ***Methods:*** We considered our 9 recent publications from 2018 to 2024, with a focus on several key factors associated with an increase in AB resistance. ***Results:*** We show that high animal productivity is possible with low use of antibiotics; and that the use of antibiotics in low and middle income countries is often not based on solid medical indications; and that there are other means but regulations to reduce the use of antibiotics. In resource-poor settings, enforcing and complying with regulations can be challenging. Thus, we have identified a rational approach that successfully reduced the use of antibiotics without undermining animal productivity. It is based on effective health management routines and biosecurity and has been promoted by FAO and CGIAR. ***Conclusions***: Knowledge and awareness among farmers do not necessarily lead to changed behaviors. Effective incentives are required to encourage the rational use of antibiotics. Research in the field of veterinary medicine could focus on the social sciences, particularly economic issues, with a view to improving AB use.

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■ INTRODUCTION

Antibiotic resistance is threatening both human and animal health. When misused, antibiotics can become ineffective against the microbial diseases they are supposed to cure. AB resistance is a typical "One Health" issue for several reasons: the same types of antibiotics are used to treat animals and humans and many bacteria are zoonotic (Robinson *et al*., 2016). It is also global issue as resistant bacteria or resistance genes do not respect national borders and can spread worldwide.

The use of antibiotics drives the emergence of resistance. Antibiotic over- and misuse should be reduced as far as possible to mitigate resistance, both in the public health sector and in the livestock sector.

The global livestock sector is the largest consumer of antibiotics in the world (Mulchandani *et al*., 2023). As a result, it has a huge responsibility in the fight against antimicrobial resistance (AMR). However, precise data on AB use in livestock, as well as on resistance, are only available in some high-income countries (e.g. European Medicines Agency, 2023; Magnusson *et al*., 2024).

Never the less, many countries, regardless of their economic development status, are introducing regulations. These include banning the use of antibiotics as feed additives for growth promotion (WOAH, 2023), controlling the sale of antibiotics by making veterinary prescriptions obligatory, and restricting the use of antibiotics critical for

1. Department of Clinical Science, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden

* Corresponding author
E-mail: ulf.magnusson@slu.se

human medicine (WHO, 2019). How effective these regulations are in terms of reducing antimicrobial use and resistance is difficult to assess. This is particularly true in low- and middle-income countries (LMICs), given the lack of reliable national data on the sales of antibiotics in the livestock sector, a proxy for antimicrobial use (AMU). In addition, the resources to enforce these regulations and encourage compliance are sometimes limited.

Even so, there are indeed promising regulatory improvements recently introduced in e.g. Vietnam and Thailand (Carrique-Mas *et al*, 2023; Thai Ministry of Agriculture, 2020).

Another approach involves interventions on farms. Some case studies have proven successful in reducing the use of antimicrobials in LMICs (Batie *et al*., 2023; Bao *et al*., 2024). In parallel, we have been investigating how to reduce the use of antibiotics to complement the regulatory framework. Our aim has been to develop approaches that can be applied regardless of national governance capacity, since government subsidies are not always available in resource-poor settings. The key to encourage farmer adoption of the different approaches is to present positive incentives, particularly economic, that allow farmers to maintain or improve animal health and productivity. Promoting the medically rational use of antibiotics may serve this purpose.

In the following section, we provide data and discuss the practical experience gained from our studies on the use of antibiotics realting to animal management in South East Asia, East Africa and Northern Europe.

■ MATERIALS AND METHODS

The concept "Medically rational use of antibiotics" was refined by an international team of experts commissioned by FAO (Magnusson *et al*., 2019; Box 1). The data on low antibiotic use and high livestock productivity were collected from public records in Sweden and Denmark (FAO, 2019; FAO, 2020).

Knowledge, attitudes and practices relating to antibiotic use and animal management among small and medium-sized livestock farmers and drug shopworkers in East Africa and South East Asia were recorded during structured interviews.

The surveys were conducted in accordance with the ethical standards of the institutional and/or national research committee and the Helsinki declaration. By drawing on previous field experience, the surveys were adapted to the specific geographical context. The general study procedure was based on: the characterization of the farming systems, including scale (e.g. family farms or commercial farms under contract); a cross-sectional study of randomly selected farms; the use of descriptive and analytic statistics to process collected data. Structured questionnaires, including questions on farm characteristics, bacterial disease history and routines for use of veterinary drugs were prepared in English and translated into the local language where the study was conducted. When possible, sampling of commensal bacteria was performed to determine the level of drug resistance. For details see Ström *et al*. (2018); Gemeda *et al*. (2020); Hallenberg *et al*. (2020); Nohrborg *et al*. (2022); Nohrborg *et al*. (2024a); Nohrborg *et al*. (2024b).

Box 1 /// *Encadré 1*

MEDICALLY EFFECTIVE USE OF ANTIBIOTICS AS DEFINED BY A GROUP OF INTERNATIONAL EXPERTS (MAGNUSSON *ET AL.*, 2019) ///
UTILISATION RAISONNÉE DES ANTIBIOTIQUES TELLE QUE DÉFINIE PAR UN GROUPE D'EXPERTS INTERNATIONAUX (MAGNUSSON ET AL., 2019)

- Phasing out use of antibiotics as growth promoters and avoiding regular preventive use of antibiotics;
- Avoiding use of the Highest Priority Critically Important Antimicrobials (CIAs) for human medicine (WHO, 2019) in animals and adhering to the OIE (now WOAH) List of Antimicrobials of Veterinary importance (OIE, 2021);
- Only using antibiotics based on a diagnosis of disease by a veterinarian or other health professional and only for authorized indications;
- Striving for individual treatment of animals with the correct dose and duration and avoiding using antibiotics for group treatments, especially in feed, except for poultry flocks; using only quality-assured pharmaceuticals and always consulting an animal health professional before use;
- Disposing of unused and expired antibiotics in a proper way.

■ RESULTS AND DISCUSSION

Low antibiotic use and high productivity is possible

Practical experience from the livestock sectors in Sweden and Denmark show that very high productivity (FAO, 2019; FAO, 2020) can be achieved with low levels of antibiotic use (10.6 mg/population corrected unit and 34.1 mg/population corrected unit, respectively) (European Medicines Agency, 2023). For instance, in Sweden in the 80's, farmers demanded a ban on growth promotors in order to harness consumer trust in their products. Since then, farmers have worked closely with researchers, veterinarians and authorities with the aim of maintaining animal health and thereby reducing the need for antibiotics (Wierup *et al*., 2001, FAO, 2020). Although these examples are from high-income countries with very professional farmers, highly skilled veterinary services and supporting resources, they illustrate the principle that investment in good animal husbandry, biosecurity and other preventive measures to control disease without resorting to the use of antibiotics does pay off. Similar actions to promote good practices could be transposed and adapted to LIMICs.

Access to veterinary services and antibiotics

Farmers seek advice on antibiotic use from various sources (Magnusson *et al*., 2021). Most smallholders in LMICs buy antibiotics over the counter without a prescription. Instructions for use are provided by the person selling the drug. However, several studies highlight the widespread and arbitrary use of antimicrobials. Farmers often use their own judgment to adjust treatment duration and dosage (Ström *et al*., 2018; Gemeda *et al*., 2020; Hallenberg *et al*., 2020; Nohrborg *et al*., 2022; Nohrborg *et al*., 2024b). Professional veterinary services are rarely involved, either because no services are available or because smallholders cannot afford them. However, larger farms in a given country may have access to competent veterinary services. The general trend observed reveals that access to veterinary advice is directly linked to farm size and, therefore, to the farmer's financial capacity (Hallenberg *et al*., 2020).

It is frequently claimed that farmers in low- and middle-income countries do not have access to adequate antibiotics for their livestock, especially in rural areas. This is confirmed by a study in north eastern Thailand, which revealed a higher resistance rate in pigs on farms

closer to drugstores than in pigs on farms further away (Huber *et al*., 2021).

The sale of falsified drugs in low- and middle-income countries is also a common problem (Kelesidis & Falagas, 2015). A systematic review of 96 studies revealed a prevalence of 12% for substandard and falsified antibiotics in low- and middle-income countries (Ozawa *et al*., 2018).

By identifying the problems and causes of antibiotic over- and misuse, these findings will contribute to encourage the medically rational use of antibiotics. Over time, this may reduce resistance and at the same time support effective animal production in LMICs.

Knowledge and attitudes relating to antibiotic use in livestock

In the low- and middle-income areas and populations studied, knowledge about antibiotic use and antimicrobial resistance varies considerably, ranging from poor to adequate (Ström *et al*., 2018; Nohrborg *et al*., 2024a). One consistent finding shows that "adequate" knowledge does not automatically translate into desired behavioral change (Osbjer *et al*., 2015; Nohrborg *et al*., 2024a). This is a well-established phenomenon in social science, which underlines the importance of providing more effective incentives to reduce the overuse and misuse of antibiotics in livestock systems. Most studies highlight the fact that a broader approach is needed to change farmers' behavior and to encourage the adoption of a medically rational use of antibiotics. Key players, such as drug shopworkers, should be involved in the process. Other factors should also be taken into account, such as commercial interests, knowledge of diseases and the lack of proper diagnosis.

Antibiotic use and alternative disease prevention measures

In several of the studied sites farmers reported that they used antibiotics on a regular preventive basis. They also stated that they frequently used critically important antibiotics (CIAs) or that the drug shop sold CIAs to farmers (Ström *et al*., 2018; Gemeda *et al*., 2020; Hallenberg *et al*., 2020; Nohrborg *et al*., 2024b). Several studies revealed flaws in the non-antbiotic disease prevention measures (Hallenberg *et al*., 2020; Nohrborg *et al*., 2022, Nohrborg *et al*., 2024a).

Numerous factors influence farmers' practices. Access to professional veterinary services for advice on antibiotic use is a major issue. Developing public-private partnerships could improve access in some cases. Farmers may have a limited understanding of the protocol for using the antibiotics they buy from veterinary pharmacies. Providing training for farmers and animal health professionals would be of benefit. It could also boost farmer motivation. For example, farmers in LIMICs might change their practices if they knew that the medically rational use of antibiotics in the livestock sector in Sweden and Denmark has reduced the need for antibiotics and concomitantly maintained and supported high productivity. The effective use of antibiotics for preventive or curative treatment depends on an accurate diagnosis (Box 1), which is often lacking. Notably, within the same national legal framework disparate geographical and diverse socio-economic context may influence the adoption of good practices.

More in-depth observational studies on farms that focus on animal management and biosecurity measures are required before any firm conclusions can be drawn. Further studies should also examine farmers' motivation to improve their animal husbandry practices. The question of motivation is essential because good animal management and adequate biosecurity measures are prerequisites for a medically rational use of antibiotics in the livestock production sector (Figure 1).

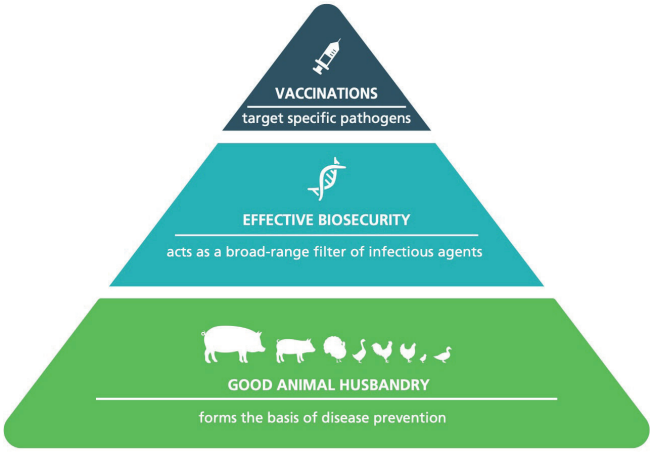

Figure 1: The three main measures to prevent infectious diseases in a farm /// *Les trois principales mesures pour prévenir les maladies infectieuses dans un élevage*

■ CONCLUSION

The adoption of a more medically rational use of antibiotics may be a motivation for farmers in low- and middle-income countries to improve their productivity and reduce the need for antibiotics. However, there is a set of hurdels that must be overcome: poor access to competent and affordable veterinary services, farmers' limited skills and lack of resources for adequate disease prevention measures. It is important to note that improving farmers' knowledge and awareness does not necessarily induce change in their behavior. To address this, veterinary medicine should put greater emphasis on the social sciences, particularly economics. This would help identify effective incentives, which are not based on subsidies, and could encourage farmers to adopt a medically rational use of antibiotics in their livestock production systems.

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Conflicts of interest

The study was carried without any conflict of interest.

Author contributions

UM: conception and design of the review, data analysis. Writing - Original Draft, revision of the manuscript.

Ethics approval

Approval from an ethics committee regarding the use of animals was not necessary for this study because data were collected from previously published sources.

Data availability

Part of the data were deposited in an official repository. Other data that support the study findings are available from the authors upon request.

Declaration of Generative AI in the writing process

The authors did not use any artificial intelligence-assisted technologies in the writing process.

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Résumé

Magnusson U. Utilisation rationnelle des antibiotiques pour réduire la résistance et soutenir une production animale efficace dans les pays à revenu faible et intermédiaire

Contexte : La résistance aux antibiotiques constitue une menace pour la santé humaine et animale. Le problème est exacerbé par le fait que des médicaments antimicrobiens similaires sont utilisés pour traiter à la fois les animaux et les humains. Le secteur mondial de l'élevage est le plus grand consommateur d'antibiotiques au monde. Étant donné que l'utilisation d'antibiotiques favorise l'émergence de résistances, il est essentiel de réduire leur utilisation dans le secteur de l'élevage, non seulement pour la santé animale, mais aussi pour la santé publique. Pour lutter contre le problème de la résistance aux antibiotiques, les pays mettent en place des réglementations qui comprennent l'interdiction de l'utilisation d'antibiotiques comme additifs alimentaires pour favoriser la croissance, l'obligation d'une prescription vétérinaire pour la vente et la restriction de l'utilisation d'antibiotiques d'importance critique pour la médecine humaine. ***Objectif*** : Cet article partage notre expérience pratique et résume les données issues de nos études sur l'utilisation des antibiotiques dans le cadre de la gestion animale en Asie du Sud-Est, en Afrique de l'Est et en Europe du Nord. ***Méthodes :*** Nous nous sommes basés sur nos 9 publications récentes, de 2018 à 2024, en nous concentrant sur plusieurs facteurs clés associés à une augmentation de la résistance aux antibiotiques. ***Résultats :*** Nous montrons qu'il est possible d'obtenir une productivité animale élevée tout en réduisant l'utilisation d'antibiotiques, que l'utilisation d'antibiotiques dans les pays à revenu faible ou intermédiaire n'est souvent pas fondée sur des indications médicales solides, et qu'il existe d'autres moyens que la réglementation pour réduire l'utilisation d'antibiotiques. Dans les milieux pauvres en ressources, il peut être difficile de faire respecter et d'appliquer les réglementations. Nous avons donc identifié une approche rationnelle qui a permis de réduire l'utilisation des antibiotiques sans nuire à la productivité animale. Elle repose sur des mesures efficaces de gestion de la santé et de biosécurité et a été promue par la FAO et le CGIAR. ***Conclusions*** : Les connaissances et la sensibilisation des agriculteurs ne conduisent pas nécessairement à un changement de comportement. Des mesures incitatives efficaces sont nécessaires pour encourager l'utilisation rationnelle des antibiotiques. La recherche dans le domaine de la médecine vétérinaire pourrait se concentrer sur les sciences sociales, en particulier les questions économiques, en vue d'améliorer l'utilisation des antibiotiques.

Mots-clés : Bétail, résistance aux antibiotiques, sécurité biologique, gestion de la maladie, hygiène, Afrique, Asie

Resumen

Magnusson U. Uso racional de los antibióticos para reducir la resistencia y favorecer una producción animal eficaz en los países de renta baja y media

Contexto: La resistencia a los antibióticos constituye una amenaza para la salud humana y animal. El problema se amplifica porque se utilizan medicamentos antimicrobianos similares para tratar a animales y a humanos. El sector de la ganadería es el mayor consumidor de antibióticos a escala mundial. Teniendo en cuenta que la utilización de antibióticos favorece la emergencia de resistencias, se debería reducir su uso en el sector ganadero, no solamente para la salud animal, también para la salud pública. En su lucha contra el problema de la resistencia a los antibióticos, los países aplican reglamentaciones que incluyen la prohibición del uso de antibióticos como aditivos alimenticios para favorecer el crecimiento, la obligación de una prescripción veterinaria para la venta y la restricción del uso de antibióticos de importancia crítica para la medicina humana. ***Objetivo***: Este artículo comparte nuestra experiencia práctica y resume los datos provenientes de nuestros estudios sobre la utilización de antibióticos en el marco de la gestión animal en el sudeste asiático, en el este de África y en el norte de Europa. ***Métodos:*** Nos basamos en nuestras nueve publicaciones recientes, de 2018 a 2024, concentrándonos en varios factores clave asociados a un aumento de la resistencia a los antibióticos. ***Resultados:*** Mostramos que es posible obtener una productividad animal elevada reduciendo el uso de antibióticos; que el uso de antibióticos en los países con rentas débiles o medias a menudo no se basa en indicaciones médicas sólidas, y que existen otros métodos para reducir el uso de antibióticos, a parte de la reglamentación. En los medios pobres en recursos puede resultar difícil hacer respetar y aplicar las reglamentaciones. Hemos identificado, pues, un enfoque racional que ha permitido reducir el uso de los antibióticos sin perjudicar a la productividad animal. Se basa en medidas eficaces de gestión de la salud y de bioseguridad y es promovido por la FAO y el CGIAR. ***Conclusiones***: El conocimiento y la sensibilización de los agricultores no conducen necesariamente a un cambio de comportamiento. Hacen falta iniciativas eficaces para estimular la utilización racional de los antibióticos. La investigación en el campo de la medicina veterinaria podría concentrarse en las ciencias sociales, en particular en cuestiones económicas, con vistas a mejorar el uso de los antibióticos.

Palabras clave: Ganado, resistencia a los antibióticos, bioseguridad, gestión de la enfermedad, hygiene, África, Asia