Smarter Strategies to Combat Worm Resistance in Sheep and Goats

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Introduction

Sheep and goats are essential to agricultural systems globally, thriving from small family farms to expansive commercial farms across diverse landscapes. These hardy animals convert marginal grazing lands, often unsuitable for crops or other livestock, into valuable products such as meat for nutrition, milk for dairy, wool for textiles, and manure for soil enhancement. In many regions, they strengthen food security and support rural livelihoods, particularly in areas with limited resources, where their low-maintenance nature proves advantageous. Their ability to browse on shrubs and weeds also aids land management, helping control vegetation and reduce fire hazards in vulnerable terrains.

Despite their resilience, these animals face a persistent threat from gastrointestinal worms, among the most damaging parasites affecting flock health. These worms drain nutrients, leading to stunted growth in young stock, reduced milk yields in lactating animals, compromised reproduction with lower fertility rates, and, in severe cases, death from anemia or secondary infections. In warmer climates, the barber's pole worm (*Haemonchus contortus*), a blood-feeding parasite, causes rapid anemia and sudden losses, while other nematodes like *Trichostrongylus*, *Teladorsagia*, and *Cooperia* cause chronic damage by disrupting digestion and causing weight loss or diarrhea. The economic toll is significant, with losses from reduced productivity and control measures impacting farmers worldwide, particularly in developing regions where they deepen economic challenges. For years, chemical dewormers, or anthelmintics, provided a reliable solution, quickly restoring health to affected flocks and supporting intensive farming practices. Introduced in the mid-20th century, these drugs, spanning benzimidazoles to macrocyclic lactones, were celebrated for their effectiveness, boosting yields and enabling higher stocking densities. However, excessive use has led to a growing crisis of resistant worms' population to these once-reliable treatments. This resistance, driven by genetic adaptations in worm populations under constant drug pressure, has rendered many controls ineffective, raising costs and threatening flock viability. Recent observations in communal farming areas, such as those in India, show multi-drug resistance in *Haemonchus* strains, with a high percentage of goats retaining significant egg counts after treatment. Climate change exacerbates the issue by extending parasite transmission seasons with warmer temperatures and unpredictable rainfall, while subclinical infections reduce weight gain, wool, and milk production, costing the global industry billions. The interconnected health risks to humans and animals, highlighted by shared soil-transmitted helminths, underscore the need for integrated, sustainable management strategies to ensure long-term flock health.

Historical Context: From Miracle Drugs to Resistance Challenges

Before modern anthelmintics, farmers relied on traditional knowledge and practical adjustments to manage worm infestations. Ancient herders noticed seasonal patterns, moving flocks to higher or drier ground during wet periods to limit larval exposure. By the 19th century, homegrown remedies like herbal mixtures offered partial relief, though wet seasons still posed significant risks, with moisture accelerating larval development and causing substantial losses among vulnerable young animals. These methods constrained herd growth and strained resources in the absence of effective treatments. The mid-20th century marked a turning point with the introduction of powerful anthelmintics, beginning with broad-spectrum drugs like thiabendazole in the 1950s, followed by levamisole in the 1960s, and ivermectin, a revolutionary macrocyclic lactone, in the 1980s. These treatments transformed farming, restoring vigor to weakened flocks, enhancing wool and milk production by significant margins, and supporting intensive grazing systems. The ease of use encouraged routine, calendar-based dosing, often without assessing infection levels, fueling a sense of limitless control.

However, this reliance triggered an evolutionary response. Worms, with their rapid reproduction and genetic diversity, developed resistance through rare survival mutations amplified by repeated drug exposure. Resistance first appeared decades ago against early drugs and spread globally to include benzimidazoles, levamisole, and macrocyclic lactones by the late 20th century. Practices like under-dosing and moving treated animals to clean pastures accelerated this trend, favoring resistant strains. Today, multi-drug resistance is widespread, with communal grazing systems reporting high failure rates of common anthelmintics. Farmer awareness often lags, perpetuating outdated practices, while new drug classes face slow adoption due to resistance concerns. The economic impact is severe, with subclinical infections reducing growth and yields, and total drug failures in some areas signaling a critical need for alternative strategies. Historical lessons emphasize that over-reliance on chemicals is unsustainable, necessitating a shift to integrated management.

Understanding Refugia: A Key to Slowing Resistance

Refugia offers a new perspective on parasite control, shifting the goal from eradicating all worms to preserving a population unexposed to drugs. This untreated segment found in undosed animals or as eggs and larvae on pastures maintains susceptible genes that dilute resistance when interbreeding with survivors from treated hosts. This dilution slows the spread of resistant traits, keeping 20-30% of worms in refugia can significantly delay resistance development, especially for highly reproductive species like *Haemonchus*.

Practical application involves avoiding blanket treatments during low-risk periods, leaving a portion of the flock untreated, or delaying moves to fresh pastures after dosing to allow re-exposure to unselected larvae. Studies on mixed grazing systems suggest treating animals after shifting to fields with lower refugia to maintain genetic diversity. Challenges include farmer hesitation to leave worms untreated, but training programs demonstrate benefits, such as reduced drug use and sustained productivity. Climate change, with its extended larval survival due to warmer conditions, requires adjustments to refugia strategies. Its role in One-Health approaches, connecting animal and human parasite control, further highlights its importance. As resistance grows, refugia stands as a foundational element, complementing monitoring and genetic efforts for sustainable flock management.

Over-Dispersion: Nature's Clue to Selective Treatment

Over-dispersion reveals that parasite loads are unevenly distributed, with a small percentage of animals carrying the majority of worms. Typically, 20-30% of a flock harbors 70-80% of the parasite burden, influenced by genetic resistance, grazing habits, and physiological states. Animals with stronger natural immunity expel larvae more effectively, while those under stress such as young or pregnant stock or those grazing closer to contaminated ground face higher exposure. This pattern, recognized for decades, supports selective treatment, targeting only the most affected individuals to maximize refugia and reduce overall drug use. These enable significant reductions in treatment frequency up to 50-70% while maintaining flock health. Combining this approach with tools like FAMACHA and faecal egg counts enhances accuracy, promoting sustainable practices by focusing resources where they are most needed.

The FAMACHA System: Precision Targeting for Anemia

The FAMACHA system provides a practical method to combat anemia caused by *Haemonchus contortus*, using a simple eyelid color check to identify affected animals. A chart rates colors from 1 (healthy red) to 5 (severe white), allowing farmers to treat only those showing signs of anemia while sparing the rest, thus preserving refugia. Developed for resource-limited settings, it requires minimal equipment just a careful eyelid lift and basic training to ensure accuracy and prevent injury. Its heritability aligns with blood parameters, making it useful for breeding programs. Field trials show most ewes can remain untreated, with lactating animals needing additional doses. Though limited to blood-feeding worms and requiring frequent checks during peaks, its effectiveness in reducing mortality and treatment use is widely validated, supporting integrated parasite management amid rising resistance.

Monitoring Worm Burdens: The Power of Faecal Egg Counts

Monitoring is central to effective parasite control, with faecal egg counts (FECs) providing a clear picture of infection levels and trends. By sampling faeces from a small group of animals and examining the faecal smear under a microscope, farmers can determine eggs per gram (EPG), reflecting contamination risks. While not pinpointing specific species without further analysis, FECs track changes a sharp increase often signals the need for action and support reduction tests to detect resistance by comparing counts before and after treatment, with a 95% drop indicating efficacy. Standardized protocols recommend sampling a minimum number of animals, and advanced techniques like PCR help identify resistance genes early. Training programs teach these methods, advising waits of 10-14 days post-treatment for accurate tests, and integrate them with other tools for peak-season monitoring. Accessible to farmers with basic skills, FECs reduce unnecessary dosing, guiding evidence-based decisions as resistance challenges grow.

Strategic vs. Tactical Deworming: A Balanced Approach

Strategic deworming, with its fixed, flock-wide treatments to prevent infections, was once standard but contributed to resistance by eliminating susceptible worms. Tactical deworming, driven by real-time data from egg counts, seasonal patterns, or clinical signs, offers a more responsive alternative, treating only when necessary. Hybrid approaches combine timed interventions during high-risk periods with selective treatments for affected animals, adapting to local conditions continuous monitoring in wet climates, seasonal focus in drier ones. The approach cuts resistance while preserving refugia, with pre-breeding doses protecting newborns and tactical adjustments following monitoring data. Integrated programs further reduce drug use by half, identifying animals for culling, and combine nutrition and grazing strategies for a holistic approach, sustaining treatment effectiveness.

Pasture Management: Disrupting the Worm Lifecycle

Pastures serve as breeding grounds for worm larvae, making their management crucial to breaking the parasite cycle. Eggs hatch in warm, moist conditions, with larvae maturing in a week or two; rotating pastures allows fields to rest for several months, enabling larval die-off. Grazing multiple species reduces parasite loads, as different animals target varied forage heights and ingest species-specific larvae. Maintaining taller grass and using feeding troughs minimize larval intake, while avoiding overcrowding limits faecal contamination. Guidelines recommend frequent rotations every few days in wet conditions, weekly in dry tailored to climate, boosting forage growth and drought resilience. These practices can cut drug use, enhancing genetic and nutritional efforts for long-term control.

Breeding for Resistance and Resilience: A Genetic Shield

Breeding focuses on resistance, preventing worm establishment, and resilience, thriving despite infection, to lessen reliance on drugs. Hardy local breeds outperform imported stock in parasite-heavy environments, showing fewer treatments. Selection uses egg counts, growth rates, and anemia scores to guide mating, with genetic progress supported by moderate heritability. Programs develop traits for climate adaptation, enhancing production and resilience over generations. Research identifies genes for milk yield and environmental tolerance, with strategies tailored to regional conditions. Educational resources promote resistant stock, and integrated nutrition amplifies these gains, building flocks that thrive with minimal chemical input.

Nutrition: Fueling Immunity Against Worms

Nutrition strengthens natural defenses, with adequate protein supporting antibody production and minerals like copper and selenium boosting immunity. Deficiencies increase vulnerability, especially during high-demand periods like lactation or growth, but supplements must be carefully managed to avoid toxicity. Strategic feeding during peak worm seasons, using diets with at least 7% protein, reduces infection impact by enhancing resilience. Balanced rations cut parasite loads significantly, and mineral support targets specific threats, with integrated feeding plans amplifying the effectiveness of other control measures.

Dewormer Rotation and Combinations: Extending Drug Life

Rotating anthelmintic classes or combining different drugs targets varied worm susceptibilities, potentially slowing resistance if efficacy remains. Rotation across seasons or using multi-active treatments requires regular testing to ensure relevance, as some evidence suggests combinations outperform rotations alone against resistant strains. These methods supplement, rather than replace, refugia preservation and targeted treatments, fitting into broader management frameworks to extend drug lifespan.

Avoiding Drench-and-Move: Preventing Resistant Spread

The practice of treating animals and immediately moving them to clean pastures spreads resistant worms, accelerating resistance. Delaying relocation by a few days or co-grazing untreated animals alongside treated ones dilutes this effect, preserving susceptible populations. Accurate dosing with calibrated equipment and avoiding under-treatment further support this approach, aligning with holistic management to maintain control efficacy.

Integrated Parasite Management: A Holistic Framework

Integrated Parasite Management (IPM) unites selective dosing, pasture rotations, breeding, nutrition, and judicious drug use into a cohesive plan to reduce losses and resistance. It prioritizes chemicals as tools, not defaults, timing treatments based on monitoring, preserving refugia, and leveraging genetics for lasting benefits. Regional models demonstrate success, cutting drug dependency while sustaining productivity, with tailored plans adapting to local climates and conditions.

Regional Parasite Control Calendars: Timing Interventions

Control calendars align actions with parasite lifecycles, adjusted to local weather patterns. In wetter regions, intensive monitoring and dosing target the start and peak of rainy seasons, focusing on young or pregnant animals. Drier areas prepare before wet periods to limit contamination, while temperate zones address spring and autumn peaks, with pre-lambing treatments safeguarding newborns. Arid climates respond after rains to manage brief larval surges. Customized tools refine these schedules with farm-specific data, ensuring timely and effective interventions.

Climate-Specific Risk Periods: Adapting to Environment

Wetter climates face continuous worm threats, intensified by rainfall, requiring constant vigilance. Drier regions experience seasonal infection rises, with strategic dosing before wet spells. Temperate areas prepare for transitional peaks in spring and autumn, using cooler seasons for control measures. Arid zones address sudden larval blooms after rain. Changing climates extend these risk periods, demanding flexible, adaptive strategies to stay ahead.

Practical Implementation Guidelines: Actionable Steps

Effective control weaves multiple strategies into daily routines. Regular egg counts during high-risk seasons inform decisions, with priority monitoring for young, pregnant, or weak animals. Treatments rely on evidence from counts or symptoms, avoiding blanket applications. Pasture rotations separate age groups, allowing larval decline, while balanced nutrition and breeding from resilient stock build immunity. Annual reviews of treatment, monitoring, and weather data refine approaches, ensuring adaptability to evolving conditions.

Adapting to Changing Conditions: Staying Ahead

Parasite management must evolve with shifting environments, rising resistance, and farm dynamics. Changing climates extend transmission seasons, with warmer winters sustaining larvae and erratic rains triggering outbreaks. Introducing new stock risks importing resistant worms, necessitating quarantine and testing. Ongoing advice from veterinarians or extension services keeps practices current with emerging tools and insights, supporting long-term sustainability.

Long-Term Outlook: Building Sustainable Flock Health

Sustainable control balances intervention with tolerance, keeping worm levels below harmful thresholds to avoid losses while preserving drug effectiveness. Through vigilant monitoring, strategic treatments, pasture care, nutrition, genetic selection, and responsible drug use, IPM fosters resilient flocks. This proactive shift from reactive dosing to preventive systems ensures thriving herds and viable farms for the future, addressing the urgent challenge of global resistance trends.

Conclusion

The escalating challenge of worm resistance in sheep and goats demands a transformative approach that transcends reliance on chemical dewormers, paving the way for sustainable flock management. The integration of Integrated Parasite Management (IPM) encompassing selective treatments, pasture rotations, genetic selection for resistance, nutritional support, and strategic drug use offers a robust framework to mitigate losses while preserving anthelmintic efficacy. By leveraging tools like FAMACHA and faecal egg counts, farmers can make informed decisions tailored to local climates and evolving conditions, ensuring resilience against climate-driven threats and emerging resistant strains. This holistic shift not only safeguards flock health and productivity for future generations but also aligns with broader One-Health goals, fostering a balanced coexistence with parasites that supports both animal welfare and rural livelihoods.

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