Rethinking Growth Promoters Through the Lens of Green Chemistry

As veterinary medicine continues to evolve, so too do the expectations around how treatments are developed and produced. In recent years, there has been a significant shift towards more sustainable and environmentally conscious pharmaceutical manufacturing. This is particularly relevant in animal health, where high-volume APIs like growth promoters are widely used – and where their method of production can carry a considerable environmental footprint.

The call for greener processes is not just a matter of compliance. It reflects growing industry-wide recognition that environmental responsibility must be integrated into the earliest stages of drug development. Regulators are introducing stricter guidelines around solvent usage, waste generation, and energy consumption. Meanwhile, customers, investors, and other stakeholders increasingly expect companies to align their manufacturing practices with broader sustainability goals.

Within this context, green chemistry has emerged as a critical tool – not simply as a cost-saving measure, but as a strategic imperative. And yet, implementing green chemistry principles in active pharmaceutical ingredient (API) synthesis remains a formidable challenge, particularly when working with legacy molecules and multi-step synthetic routes.

One of the most instructive areas for exploring these challenges – and potential solutions – is in the synthesis of growth promoters. These compounds, used to support feed efficiency and animal weight gain, are typically administered on a large scale. As such, even incremental improvements in their manufacturing process can result in substantial environmental benefits.

Rethinking Traditional Synthesis

Conventional synthesis of growth promoters often involves solvent-intensive processes, toxic reagents, and energy-heavy conditions. These routes may have been developed for speed or cost-effectiveness decades ago, but they frequently fall short by today's environmental and safety standards.

In response, some development teams are now undertaking complete re-evaluations of synthetic routes, applying green chemistry principles from the ground up. One key focus has been the elimination of column chromatography in favour of crystallisation-based purification methods, which significantly reduce both silica waste and solvent consumption. In many cases, process steps are being telescoped – merged together without isolating intermediates – to minimise processing time and material usage. Hazardous solvents, including carcinogenic Class 2 options used in earlier processes, are being replaced with less toxic alternatives to reduce health and environmental risks. Common choices include replacing metal lactate with lactic acid and substituting pyridinium salts with safer, more economical coupling agents. These changes not only support safety and sustainability but also improve compatibility across steps. Reagent selection is increasingly guided by cost-efficiency as well, ensuring that the switch to greener materials doesn't compromise commercial viability. Another area of emphasis is temperature control; by designing reactions to proceed at ambient conditions, developers can reduce energy usage and mitigate the risks associated with thermal hazards.

A Structured Approach to Greener Synthesis

What's increasingly clear is that sustainability-driven process design doesn't happen by chance – it requires deliberate methodology. One effective framework gaining traction is the SELECT criteria approach, which evaluates potential process improvements across dimensions like Safety, Environment, Legal, Economics, Control, and Throughput.

Applied thoughtfully, SELECT allows chemists and engineers to balance complex trade-offs – for example, choosing a slightly lower-yielding reaction if it eliminates a hazardous solvent or significantly reduces waste.

Additionally, the use of Design of Experiments (DoE) and other systematic optimisation techniques is helping teams arrive at greener, more robust processes more efficiently. These tools not only fine-tune reaction conditions, but also help identify control strategies that ensure consistent product quality at scale.

From Lab to Commercial Scale

Developing a green process at lab scale is one thing; implementing it reliably at manufacturing scale is another. A common pitfall is overlooking the nuances of scale-up – such as heat transfer, mixing, and reaction kinetics – that can affect yield or product purity.

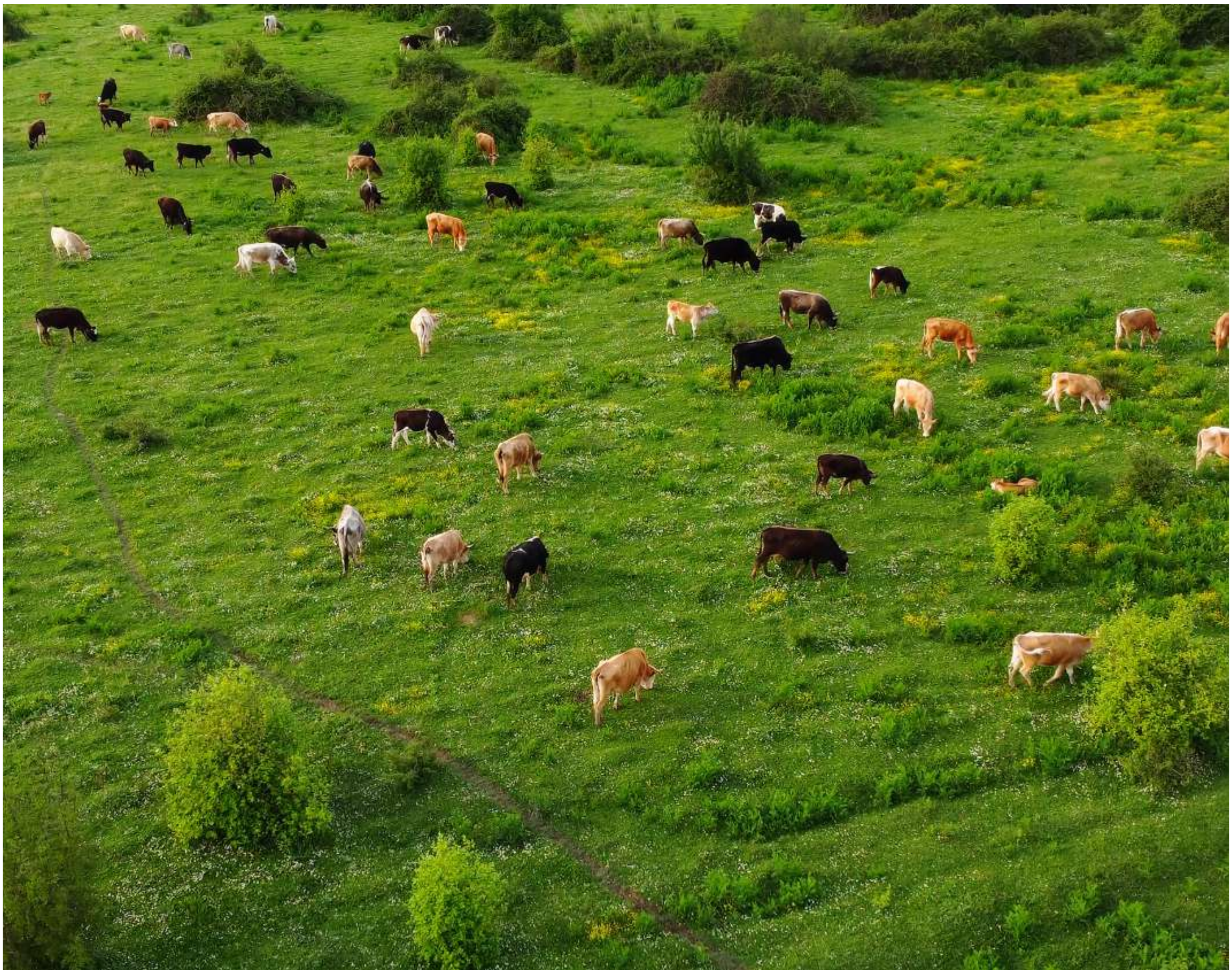
Successful projects often involve close collaboration between process development and manufacturing teams, ensuring that what works in the flask can be reproduced consistently in multi-kilogram or commercial batch settings. Early identification of critical process parameters (CPPs) and a clear understanding of critical quality attributes (CQAs) is key to bridging that scale-up gap.

One recent case involved the re-engineering of a multi-step growth promoter synthesis that originally relied on column chromatography and costly, hazardous reagents. Through a series of redesigns, including route modification, solvent swaps, and step consolidation, the process team was able to reduce waste, lower solvent usage by 20%, and improve overall yield by over 15% – all while maintaining the required purity and impurity profile for regulatory submission.

Critically, the process was developed to be chromatography-free, enabling better reproducibility and significant environmental savings. The new route resulted in an 80% reduction in both the cumulated environmental factor (cE-factor) and process mass intensity (PMI) – two key metrics used to measure environmental impact in pharmaceutical manufacturing.

Broader Implications for Animal Health Manufacturing

The example above is not unique, but it is illustrative. As the animal health sector becomes more global, more tightly regulated, and more attuned to environmental impact, the



expectations around how veterinary drugs are developed will only rise.

Growth promoters – often produced in large volumes – are a prime target for sustainable innovation. But the same principles apply across a wide range of veterinary APIs, from anti-parasitics to anti-infectives. In each case, the question is the same: how can we make the process cleaner, safer, more efficient – and still meet the commercial and therapeutic goals?

For many companies, this will mean working more closely with development partners who bring a multidisciplinary perspective to the table: deep synthetic chemistry knowledge, process engineering expertise, and a commitment to sustainable practices. Whether in-house or through external collaboration, it is this integration of science, strategy, and sustainability that will define the next generation of animal health manufacturing.

Looking Forward

Green chemistry is not a passing trend in animal health – it is becoming central to how responsible, forward-looking companies develop products. As pressure mounts from regulators, investors, and end consumers, the ability to rethink established synthesis routes and adopt greener alternatives will increasingly define competitive advantage.

In this context, project success should be measured not just by yield or cost, but by how well the process aligns with broader goals of safety, sustainability, and scalability. Whether applied to new molecular entities or re-engineered legacy APIs, sustainable synthesis is a powerful lever for progress – one that aligns industry performance with environmental stewardship in a way that benefits everyone, from producers and veterinarians to animals and ecosystems.

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