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maceutical supply chain.

The recommendations come amid growing debate over the proposed expansion of TMR beyond the cancer medicines segment, where a pilot exercise demonstrated the potential of margin rationalisation to reduce prices for patients. Industry stakeholders, however, believe that extending the mechanism across a wider range of pharmaceutical products requires a comprehensive assessment of existing trade structures, pricing practices and the economic implications for different categories of businesses.

The issue has also been raised by pharmaceutical representatives of Laghu Udyog Bharati (LUB), an RSS-affiliated, not-for-profit pan-India organisation established in 1994 to empower micro and small enterprises. LUB's pharma representatives have also been following with the DoP and discussed several important industry concerns, including TMR, extension of the Revised Schedule M compliance timeline, hurdles relating to Revised PTUS and the formation of a Drug Tribunal Board.

During the representations to the Government, LUB Pharma proposed the concept of "One Nation-One Molecule-One MRP", advocating that the top 100 pharmaceutical companies should market their generic brands under the respective molecule names at affordable MRPs. ◆

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Pharma machinery: Backbone of quality, competitiveness

Dr. Sanjay Agrawal

The success of the pharmaceutical industry depends on more than scientific discovery and formulation expertise. Behind every tablet, capsule, injectable and liquid medicine lies a complex manufacturing ecosystem in which machinery plays a fundamental role. From processing active pharmaceutical ingredients (APIs) to producing finished dosage forms and ensuring precise packaging, pharmaceutical equipment determines how consistently, efficiently and safely medicines can be manufactured.

For India, one of the world's leading pharmaceutical manufacturing hubs, the importance of machinery is particularly significant. As the industry expands its global footprint, manufacturers must balance increasing production requirements with stringent quality expectations, cost pressures and the need for operational reliability. Modern pharmaceutical machinery has consequently become a strategic enabler of manufacturing excellence rather than simply a production asset.

The ability to invest in appropriate technology, maintain equipment performance and integrate machinery with quality systems will be central to India's continued growth as a dependable supplier to global pharmaceutical markets.

Ensuring consistent quality and product integrity

Quality is the foundation of pharmaceutical manufacturing. Medicines must contain the intended ingredients in the specified quantities and meet established standards for purity, uniformity, stability and performance. Pharmaceutical machinery supports these objectives by enabling controlled and repeatable manufacturing processes.

Equipment such as granulators, blenders, tablet compression machines, capsule fillers and coating systems performs specialised functions that directly influence the quality of finished products. Precision dosing and mixing equipment helps achieve uniform distribution of ingredients, while controlled compression and coating processes support the required physical characteristics of tablets.

Similarly, liquid-processing systems, filtration units and sterile filling equipment are essential for manufacturing products that require carefully controlled processing conditions.

Modern machinery incorporates process controls, monitoring instruments and automated operating parameters that help minimise variations between batches. When supported by appropriate validation, maintenance and operator training, these capabilities can reduce manufacturing errors and improve consistency.

Equipment alone, however, cannot guarantee quality. Its performance must be supported by robust standard operating procedures, qualified personnel, suitable raw materials and effective quality management systems. The real value of pharmaceutical machinery lies in its ability to make well-controlled processes repeatable at scale.



Pharmaceutical companies operate in an environment where production efficiency and cost competitiveness directly influence commercial performance. Machinery plays a critical role in helping manufacturers increase output while controlling operating expenses

Improving productivity and manufacturing efficiency

Pharmaceutical companies operate in an environment where production efficiency and cost competitiveness directly influence commercial performance. Machinery plays a critical role in helping manufacturers increase output while controlling operating expenses.

Automated processing and packaging lines can reduce manual intervention, improve production speed and minimise material losses. Integrated systems can also reduce delays between manufacturing stages, enabling smoother movement from raw material processing to finished product handling.

Equipment reliability is equally important. Unplanned breakdowns can disrupt production schedules, increase maintenance costs and delay customer deliveries. Preventive maintenance, timely replacement of worn components and systematic performance monitoring help improve equipment availability.

Manufacturers can assess these improvements through indicators such as production yield, down- time, rejection rates and over- all equipment effectiveness. Such measurements help identify bottlenecks and establish whether machinery investments are delivering the expected operational benefits.

For companies producing high volumes of generic medicines, even incremental improvements in productivity can have a meaningful cumulative impact. Better utilisation of existing equipment can increase output without requiring a proportionate increase in infrastructure or manpower.

Enabling scalability and advanced formulations

As pharmaceutical companies diversify their product portfolios, manufacturing equipment must accommodate different formulations, batch sizes and process requirements. Machinery that performs effectively for a conventional tablet may not be suitable for a specialised formulation or a product requiring greater containment and environmental control.

Equipment selection must therefore consider the characteristics of the product, manufacturing process and intended production scale.

For example, specialised filling systems are necessary for certain injectable products, while controlled processing environments and dedicated equipment configurations may be required for sensitive or high-potency compounds.

Biopharmaceutical manufacturing introduces additional demands involving temperature control, filtration, aseptic processing and contamination prevention.

Scalable equipment allows manufacturers to move from development and pilot production towards commercial manufacturing while maintaining appropriate process controls. Modular systems, adaptable production lines and automated recipes can also support product diversification and reduce changeover complexity.

This flexibility is becoming increasingly valuable as Indian manufacturers seek opportunities in complex generics, specialty medicines, biologics and other advanced pharmaceutical segments.

Automation and digital manufacturing

The integration of automation and digital technologies is transforming pharmaceutical production. Modern equipment increasingly incorporates programmable logic controllers, sensors, human-machine interfaces and data acquisition systems that enable more precise control of manufacturing operations.

Automation can improve process repeatability, reduce human error and provide better visibility into production performance. Digital monitoring systems can identify deviations from established operating parameters and help production teams respond before minor issues develop into larger disruptions.

Predictive maintenance offers another important advantage. By analysing equipment condition and performance trends, manufacturers can identify potential failures and plan maintenance activities more effectively.

Digitalisation can also support documentation, batch traceability and investigation of manufacturing deviations. In regulated environments, these benefits must be accompanied by validated systems, appropriate access controls, reliable records and robust data integrity practices.

Importantly, digital transformation does not require every pharmaceutical facility to replace its entire equipment infrastructure. Targeted upgrades, improved instrumentation and integration of selected production systems can help manufacturers achieve measurable improvements while managing investment costs.

Supporting regulatory compliance and patient safety

Pharmaceutical machinery must operate within the regulatory and quality requirements applicable to the products being manufactured and the markets being served.

Equipment should be suitable for its intended purpose, constructed from appropriate materials and designed to support effective cleaning, maintenance and process control. Depending on the application, manufacturers may need to demonstrate equipment qualification, process validation and documented maintenance procedures.

In India, Good Manufacturing Practices (GMP) provide an important framework for ensuring that medicines are consistently produced and controlled according to established quality standards. Machinery selection, installation and operation must align with the applicable requirements of the facility and manufacturing process.

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Sinophex showcases pharma manufacturing technologies

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Sinophex

Showcases pharmaceutical machinery and equipment, including API production equipment, pulverising equipment, formulation equipment, packaging equipment, purification systems, environmental protection equipment, pharmaceutical water systems and other pharmaceutical manufacturing technologies.

Specialised exhibition areas

This includes the biopharmaceutical supply chain exhibition area and the laboratory equipment and analytical instruments exhibition area.

These platforms provide visitors with a structured way to explore complementary products and technologies across the pharmaceutical supply chain.

The 95th API China will also feature a comprehensive conference programme covering pharmaceutical policy, innovative drug development, manufacturing technologies, quality management, R&D and international business development.

Advanced manufacturing and process optimisation

Sessions on oral solid dosage forms, API manufacturing processes and technical innovation reflect the industry's focus on improving production efficiency, process consistency and manufacturing capabilities.

Quality and regulatory compliance

Topics such as eCTD, pharmaceutical excipient compliance, laboratory management and advanced manufacturing compliance underscore the importance of quality systems, documentation and regulatory readiness.

Supply chain resilience and cost optimisation

> The emphasis on overseas expansion and pharmaceutical internationalisation reflects the industry's interest in exploring global markets, strengthening cross-border partnerships and developing new commercial opportunities

Industry trends

Innovation in drug development

The focus on peptide and oligonucleotide drugs, inhalation drug development and emerging pharmaceutical technologies highlights continued interest in innovative therapies and specialised drug development approaches.

Dedicated forums on pharmaceutical supply chain development, cost improvement and value enhancement demonstrate growing attention to operational efficiency, supply chain resilience and collaboration among industry participants.

Sustainability and green manufacturing

Environmental protection, pollution control and green development remain important priorities for pharmaceutical manufacturers seeking more sustainable production practices.

Overseas expansion and global co-operation

The emphasis on overseas expansion and pharmaceutical internationalisation reflects the industry's interest in exploring global markets, strengthening cross-border partnerships and developing new commercial opportunities.

Overall, 95th API China provides a platform for pharmaceutical companies to discuss these developments, exchange practical experience and explore new opportunities across China's pharmaceutical supply chain. ◆

China-Plus-One strategy

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Biocatalysis at the centre of green chemistry strategy

Biocatalysis is another important pillar of Fermenta's R&D strategy. As pharmaceutical manufacturers seek greater process selectivity, efficiency and sustainability, enzymes are increasingly being viewed not merely as process aids but as technology platforms capable of enabling new manufacturing pathways.

Fermenta's R&D priorities include APIs and intermediates, process optimisation, Vitamin D derivatives, enzyme development, fermentation, biotransformation and application-specific biocatalysis.

Its enzyme portfolio includes Penicillin G Acylase (PGA), CAL-B Lipase, TL Lipase and other lipases, with applications across pharmaceutical APIs. The company is increasingly focused on customised enzymes for complex molecular transformations, targeting improvements in yield, selectivity, sustainability, process efficiency and overall economics.

Green chemistry links sustainability with economics

For Fermenta, sustainability and manufacturing efficiency are closely connected. Enzymatic processes can, depending on the application, enable highly selective reactions under milder conditions, potentially reducing by-products, purification requirements, solvent consumption, energy use and processing steps.

Penicillin G Acylase is one example. With domestic Penicillin G manufacturing seeing renewed interest, Fermenta sees an opportunity to strengthen the pharmaceutical value chain within India. Similarly, CAL-B lipase can support selective transformations in chiral chemistry and specialised pharmaceutical synthesis. Nagre believes the strongest green chemistry solutions will be those that deliver both environmental benefits and commercially superior process economics.

Green Chemistry was among Fermenta's strongest growth areas in FY26, supported by the revival of domestic Penicillin G manufacturing and opportunities in international markets. The company expects enzymes to become increasingly integrated into mainstream pharmaceutical process development rather than being considered only as an alternative when conventional chemistry is inadequate.

Vision for 2030

Looking towards 2030, Fermenta aims to become a more specialised, innovation-led and globally relevant company. While Vitamin D3 will remain a key foundation, the company is building a broader portfolio encompassing plant-source Vitamin D3, specialised derivatives such as calcifediol, value-added nutritional ingredients, niche APIs and intermediates, and an expanded Green Chemistry and biocatalysis business.

With customers already spread across more than 60 countries, Fermenta intends to deepen international relationships by offering differentiated technologies rather than simply expanding its geographic footprint. The Dahej investment reflects this strategy, with manufacturing capacity being expanded in areas where the company has strong scientific capabilities, customer visibility and a differentiated proposition.

For Nagre, the larger ambition is to demonstrate how an Indian pharmaceutical ingredients company can use deep process expertise to develop proprietary technologies, strengthen intellectual property and scale innovation globally.

By 2030, Fermenta's success will ultimately be measured by its ability to create technologies in India that are trusted, adopted and commercially scaled across global pharmaceutical and nutrition markets. ◆

Machinery, a crucial pillar

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Packaging and inspection equipment also contribute to patient safety. Accurate filling, reliable sealing, correct labelling and effective detection of packaging defects help protect product integrity and reduce the risk of errors reaching the market.

For export-oriented manufacturers, equipment capability must additionally support the applicable requirements of destination markets. Regulatory readiness is therefore an important consideration throughout the equipment lifecycle, from procurement and commissioning to routine operation and upgrades.

Growing importance of machinery in India

India's pharmaceutical industry has considerable opportunities to strengthen its global position, but expanding production capacity alone is insufficient. Manufacturers must also ensure that their facilities can deliver reliable quality, consistent output and competitive manufacturing costs.

The domestic pharmaceutical machinery sector can contribute significantly to this objective by providing specialised equipment, engineering expertise, technical support and accessible maintenance services.

Local equipment manufacturers can help address the requirements of businesses seeking modernisation solutions suited to their production scale and operational needs. At the same time, continued investment in engineering quality, automation, precision manufacturing and after-sales service will be essential for competing internationally.

Collaboration between pharmaceutical manufacturers, machinery suppliers, packaging companies and technology providers can further improve equipment integration and operational outcomes.

Industry platforms such as CPHI and PMEC India offer opportunities for stakeholders to evaluate emerging technologies, understand changing manufacturing requirements and establish partnerships across the pharmaceutical value chain.

Conclusion

Pharmaceutical machinery is fundamental to the industry's ability to manufacture medicines safely, consistently and efficiently. Its contribution extends across product quality, production capacity, regulatory compliance, operational economics and technological advancement.

As India's pharmaceutical sector continues to evolve, manufacturers must view machinery investment as a long-term strategic decision. Selecting appropriate equipment, maintaining reliable operations and adopting relevant technological improvements can strengthen manufacturing capabilities while supporting sustainable growth.

Ultimately, the strength of a pharmaceutical manufacturing operation is determined not merely by how much it can produce, but by how reliably it can deliver medicines that meet the required standards of quality and safety. In this context, pharmaceutical machinery remains one of the most important pillars supporting the industry's future. ◆

(The author is leading pharmaceutical consultant and Editor- in Chief of IJMToday)