



2012 North American Recombinant Protein Expression Systems Technology Innovation Award



FROST & SULLIVAN



50 Years of Growth, Innovation & Leadership

Technology Innovation Award Recombinant Expression Systems North American, 2012

Frost & Sullivan's Global Research Platform

Frost & Sullivan is in its 50th year in business with a global research organization of 1,800 analysts and consultants who monitor more than 300 industries and 250,000 companies. The company's research philosophy originates with the CEO's 360-Degree Perspective™, which serves as the foundation of its TEAM Research™ methodology. This unique approach enables us to determine how best-in-class companies worldwide manage growth, innovation, and leadership. Based on the findings of this Best Practices research, Frost & Sullivan is pleased to present the 2012 North American Technology Innovation Award in Recombinant Protein Expression Systems to MicroProtein Technologies.

Significance of the Technology Innovation Award

Key Industry Challenges

Recombinant Expression Systems are among the most integral research and drug discovery tools today. The evolution of this technology has spanned several years, and it has incorporated different media ranging from bacteria to transgenic plants. However, bacterial expression remains the preferred method for the production of recombinant proteins. The production process using this form of expression conventionally uses large fermenters that can provide high-bacteria yields. The early steps in developing recombinant pharmaceuticals, or biotherapeutics, often require multiple iterations to optimize the expression and purification of functionally active proteins. A major challenge in recombinant protein production from bacteria is the lack of post-translational modification machinery. This often leads to the production of biologically inactive protein in the host, also known as the insoluble fraction.

Three broad solution categories have been proposed to address this challenge of converting the insoluble fraction into functional proteins. The first group of solutions consists of strategies in which the factors influencing the formation of soluble fraction are modified through a tight control of the cellular milieu, thereby leading to soluble protein expression. The second group of strategies consists of refolding expressed protein from the inclusion body fraction. In the third group of strategies, the desirable protein expression is obtained in a soluble fraction through fusion protein production.

The use of fermenters also poses additional challenges including the fact that a single technology is not capable of expressing high amounts of recombinant protein. Fermenters are also more expensive in relative comparison to other bio-expression equipment, they require greater infrastructure, and specialized storage conditions. Liquid media used in the fermentation process are challenging to both procure and contain. Media-free production of

recombinant proteins, or at least the use of non-liquid media, have been proposed as solutions but they have not been viable so far due to constraints such as low yield, lack of appropriate protein folding, or incorrect disulfide bonds. In addition, fermenters are also not optimized for use in developing countries, as they require simulated temperature conditions for optimal growth, making the power requirements infeasible with regard to the power output of the particular country in question.

MicroProtein Technologies, a contract manufacturing startup based in Kansas, has been instrumental in trying to address these challenges through the development of its proprietary MPTxpress technology that provides a cost-effective production method for pharmaceutically and diagnostically relevant recombinant proteins along with the highest percentage of yield in the industry. This technology is particularly promising as a production method for biosimilars, biobetters, and biotherapeutics.

Key Benchmarking Criteria for the Technology Innovation Award

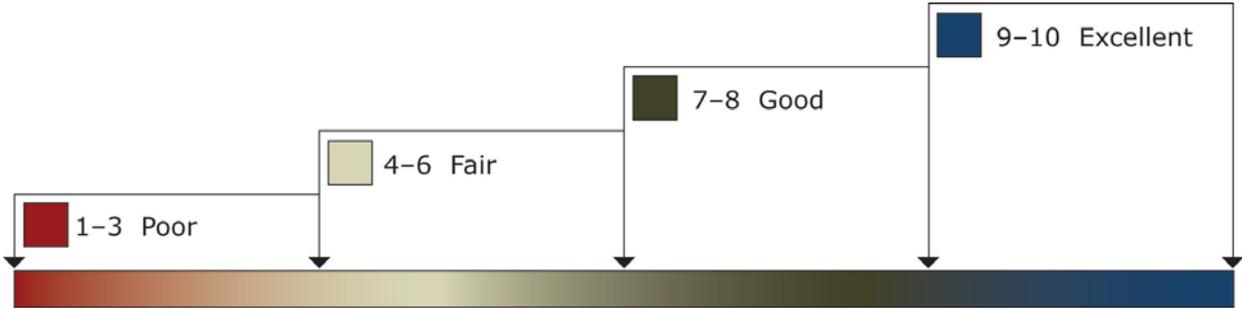
For the Technology Innovation Award, the following criteria were used to benchmark MicroProtein Technologies' performance against key competitors:

- **Uniqueness of the Technology**
- **Impact on New Products/Applications**
- **Impact on Functionality**
- **Impact on Customer Value**
- **Relevance of the Innovation to the Industry**

Decision Support Matrix and Measurement Criteria

To support its evaluation of best practices across multiple business performance categories, Frost & Sullivan employs a customized Decision Support Matrix (DSM). The DSM is an analytical tool that compares companies' performance relative to each other with an integration of quantitative and qualitative metrics. The DSM features criteria unique to each Award category and ranks importance by assigning weights to each criterion. The relative weighting reflects current market conditions and illustrates the associated importance of each criterion according to Frost & Sullivan. Fundamentally, each DSM is distinct for each market and Award category. The DSM allows our research and consulting teams to objectively analyze each company's performance on each criterion relative to its top competitors and assign performance ratings on that basis. The DSM follows a 10-point scale that allows for nuances in performance evaluation; ratings guidelines are shown in Chart 1.

Chart 1: Performance-Based Ratings for Decision Support Matrix



This exercise encompasses all criteria, leading to a weighted average ranking of each company. Researchers can then easily identify the company with the highest ranking. As a final step, the research team confirms the veracity of the model by ensuring that small changes to the ratings for a specific criterion do not lead to a significant change in the overall relative rankings of the companies.

Chart 2: Frost & Sullivan’s 10-Step Process for Identifying Award Recipients



Best Practice Award Analysis for MicroProtein Technologies

The Decision Support Matrix, shown in Chart 3, illustrates the relative importance of each criterion for the Technology Innovation Award and the ratings for each company under evaluation. To remain unbiased while also protecting the interests of the other organizations reviewed, we have chosen to refer to the other key players as Competitor 1 and Competitor 2.

Chart 3: Decision Support Matrix for Technology Innovation Award

Measurement of 1–10 (1 = lowest; 10 = highest)	Award Criteria					Weighted Rating
	Uniqueness of Technology	Impact on New Products/Applications	Impact on Functionality	Impact on Customer Value	Relevance of Innovation to Industry	
Relative Weight (%)	20%	20%	20%	20%	20%	100%
MicroProtein Technologies	9.5	9	9.5	9	9	9.2
Competitor 1	8	8.5	9	9	8.5	8.6
Competitor 2	8	8	8	7	7	7.6

Criterion 1: Uniqueness of the Technology

Employing fermenters for the production of recombinant proteins in bacteria has been a widely accepted practice for two decades. However, it has limitations in terms of required environmental conditions, storage space, and percentage yield. MicroProtein Technologies' MPTxpress production platform goes 'above and beyond' by eliminating the use of liquid media, a major factor contributing to the limitations associated with fermentation. The host that can be used for this platform is *Escherichia coli*. Conventionally, the cell growth phase of fermentation requires multiple days and large volumes of nutrients, water, and energy to produce high-product yield. This is where the uniqueness of MPTxpress comes in, as it has demonstrated the use of a solid media platform to produce higher yields of the total soluble protein. It goes through significantly less procedural steps for obtaining and extracting purified protein. Furthermore, the solid media platform is biodegradable, implying that the process is environment-friendly.

In addition to the above, Frost & Sullivan has found MicroProtein Technologies' business model to be unique. The company offers its services as a 'contract research' as well as a 'contract manufacturing' partner for the production of market ready biologics or

biopharmaceutical products. Traditionally, the production protocols are proposed by the company developing to the biologic. In this case, MicroProtein Technologies is offering value-added services as well as its technical expertise for the use of its cost-effective technology.

Criterion 2: Impact on New Products/Applications

In today's therapeutics sector, more than 60% of all biopharmaceuticals target biologics. In addition, the majority of novel pharmaceuticals and vaccines are protein-based. In the research and development phase or the production phases of the protein-based therapeutics, finding the optimal conditions for protein production is often a time-consuming and laborious process. MPTxpress reduces both these aspects by providing a rapid, reliable, and repeatable scale-up production process that reduces production costs for the companies producing biologics. The expression platform is highly suitable for the production of novel vaccines or biopharmaceuticals as well as recombinant proteins and enzymes for use in industry and research.

MicroProtein Technologies extends its services as a contract manufacturing partner and also offers its contract research services in the development of a number of components using the MPTxpress platform. These include proteins for functional studies, antigens for antibody production, therapeutic proteins and antibody fragments for preclinical and concept studies, and reagent proteins for the development of diagnostics.

In addition, as the solid media platform used in this technology is biodegradable indicating that it can be composted into fertilizer for plants, thus helping the environment.

Criterion 3: Impact on Functionality

Yield of total soluble protein has been the foremost challenge faced in bacterial expression using fermenter technology. MPTxpress is currently the production platform with the highest percentage yield of soluble protein in the industry, at a specific yield rate of up to 50% total soluble protein per load of cellular mass. It is also more robust compared to existing fermentation-based processes using liquid media. It has a faster turnaround time and lower production costs. It also offers an added advantage of being the first completely green recombinant production process in the industry implying that it leaves behind a considerably lower carbon footprint.

Criterion 4: Impact on Customer Value

The MPTxpress platform is protected under patents filed with the United States Patent and Trademark Office. It is the first technology of its kind to provide such a high-yield percentage as well as environmental-friendly features. MicroProtein Technologies has also made a unique proposition in terms of using the MPTxpress platform. They are offering a strategic partnership structure with companies manufacturing biologics and

biopharmaceuticals. In such partnerships, they act as a contract research or contract manufacturing partner by providing custom protein production services for the Bio-Pharmaceutical, Enzyme, and Plasmid DNA industries, and academic research laboratories. The environment-friendly features of the platform indicate that all components used as raw materials in the production process, from the water supply to the solid media platform, are recyclable or biodegradable.

Criterion 5: Relevance of the Innovation to the Industry

The bacterial expression system remains the most preferred choice for recombinant expression in the industry today due to its versatility and capability to produce homologous, as well as heterologous proteins. It is therefore, necessary to have a production platform that can circumvent the challenges posed by fermenters and liquid media while increasing the current yield ratio. MPTxpress has achieved all these objectives and therefore, has the potential to become the standard production protocol for bacterial expression in this \$2 billion market.

Conclusion

MicroProtein Technologies is a young company with a unique technology and a service proposition that gives it the potential to be the only contract-manufacturing partner providing end-to-end solutions for recombinant protein production. The high-yield percentage, robustness, and repeatability of the MPTxpress platform make it a versatile production platform that can be used across multiple application sectors from vaccines and biopharmaceuticals to recombinant expression for research laboratories. This technology platform with the use of a solid media platform and environment-friendly features has the capacity to be a focus for both customers as well as technology investors. Based on Frost & Sullivan's independent analysis of the North American Recombinant Protein Expression Systems market, MicroProtein Technologies is recognized with the 2012 Technology Innovation Award.

The CEO 360-Degree Perspective™ - Visionary Platform for Growth Strategies

The CEO 360-Degree Perspective™ model provides a clear illustration of the complex business universe, in which CEOs and their management teams live today. It represents the foundation of Frost & Sullivan's global research organization and provides the basis, on which companies can gain a visionary and strategic understanding of the market. The CEO 360-Degree Perspective™ is also a "must-have" requirement for the identification and analysis of best-practice performance by industry leaders.

The CEO 360-Degree Perspective™ model enables our clients to gain a comprehensive, action-oriented understanding of market evolution, and its implications for their companies' growth strategies. As illustrated in Chart 4 below, the following six-step

process outlines how our researchers and consultants embed the CEO 360-Degree Perspective™ into their analyses and recommendations.

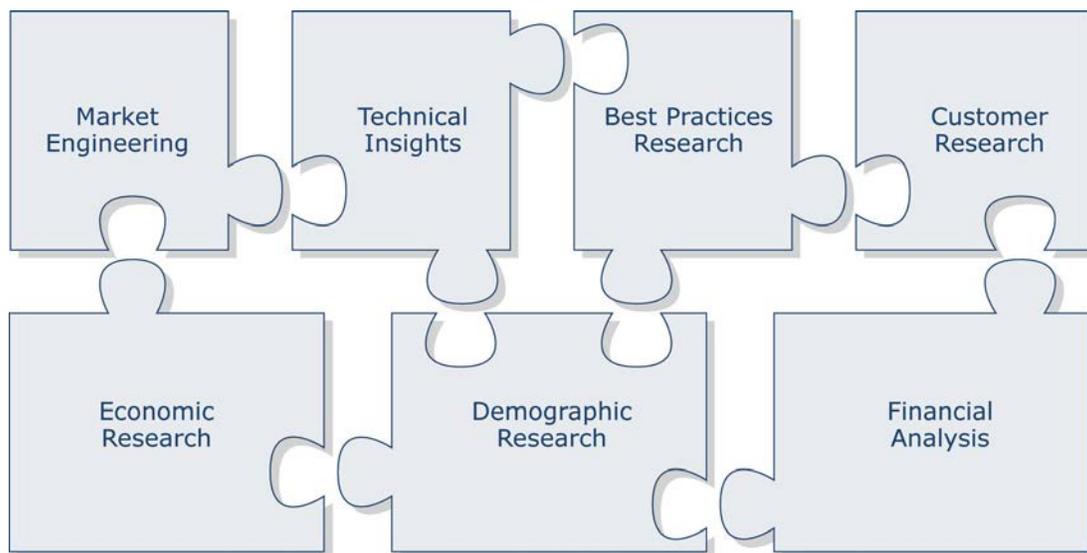
Chart 4: CEO's 360-Degree Perspective™ Model



Critical Importance of TEAM Research

Frost & Sullivan's TEAM Research methodology represents the analytical rigor of our research process. It offers a 360-degree view of industry challenges, trends, and issues by integrating all seven of Frost & Sullivan's research methodologies. Our experience has shown over the years that companies too often make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Frost & Sullivan contends that successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. In that vein, the letters T, E, A and M reflect our core technical, economic, applied (financial and best practices), and market analyses. The integration of these research disciplines into the TEAM Research methodology provides an evaluation platform for benchmarking industry players and for creating high-potential growth strategies for our clients.

Chart 5: Benchmarking Performance with TEAM Research



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation, and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best-practice models to drive the generation, evaluation, and implementation of powerful growth strategies. Frost & Sullivan leverages 50 years of experience in partnering with Global 1,000 companies, emerging businesses and the investment community from more than 40 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.