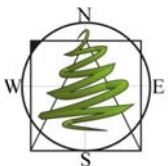


**MBA 823.3**  
**BIOTECHNOLOGY COMMERCIALIZATION**  
**PROFESSOR GRANT ISAAC**



**ARBORGEN™**  
**MARKET PROFILE**  
**FORESTRY APPLICATION**  
**OF**  
**SOMATIC EMBRYOGENESIS**



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### Background

Biotechnology in forestry, as with most industries, is in its early market development. Forestry biotechnology yet requires building more research knowledge, investigating the commercialization of forestry products, and gaining public acceptance and policies for regulation.

Current investigations into forestry biotechnology include:

- Biopulping- using a lignin-degrading fungus (lignin biodegradation) as a pre-treatment to pulping;
- Bioremediation – where formulated enzymes are used in the remediation of effluent;
- Enzyme production and characterization – where enzyme traits are measured and optimized for specific industrial applications;
- Enzyme-based bleaching - where formulated enzymes are used in pulp bleaching rather than chemical processes;
- Tree biotechnology – where specific traits of selected tree species can be optimized such as time to maturity, pathogen resistance, herbicide tolerance, and enhanced fibre quality.

The impacts of forestry biotechnology can now be found in commercial ventures. Fletcher Challenge Forests, International Paper and Westvaco Corporation formed a joint venture with Monsanto in 1999 and injected \$60 million in funding towards forestry biotechnology. Monsanto has since departed from this joint venture but the research arm has recently gone commercial in ArborGen™. ArborGen™, a company in South Carolina with research facilities in Summerville, SC and New Zealand, has taken their knowledge of forestry biotechnology to the private sector and offers services in optimized planting stock through somatic embryogenesis, currently with eucalyptus and loblolly pine. Somatic embryogenesis is a process by which somatic tissue is extracted from a selected parent stock and a germplasm is created to produce an indefinite supply of embryos, essentially an infinite supply of identical clones. This allows for plantations to optimize their planting stock for specific tree traits and responses to the ecosite in far less time than by establishing generations of root cuttings or selecting optimal seed stock from the field, given proper knowledge of the species gene sequences. This process is now being researched for its application to boreal forest species such as White spruce and Douglas fir without much success however its full commercial and scientific potential has yet to be realized.

ArborGen™'s mission statement is “to create products that benefit the consumer, sustain the environment, and provide value to the forestry industry through biotechnology.”

This analysis will explore ArborGen™'s current market strategies, identify the opportunities and threats that exist in the industry, and conclude with some strategic recommendations.

### Strategic Analysis

In conducting strategy formulation for a firm or product, the analysis should include an external study of the opportunities and threats as well as an internal analysis of the strengths and weaknesses facing the commercialization of the firm or product. This analysis has been summarized in Table 1.

ArborGen™ employs over 90 research professionals and houses state-of-the-art technology for their gene mapping and sequencing of selected eucalyptus and pine species. Other forest companies, like Weyerhaeuser, have mainly injected their funding into university level research and pilot projects with research firms. ArborGen™ is currently the only provider of somatic embryogenesis services to the forest industry and actively seeks research partnerships and data knowledge transfer with other institutions. Current global research efforts have not seen much success in the application of somatic embryogenesis on spruce and fir species though marketable products exist with loblolly and radiata pines and eucalyptus.

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## ARBORGEN™ MARKET PROFILE: FORESTRY APPLICATION OF SOMATIC EMBRYOGENESIS

Table 1 – Strategic Analysis

External	Product (Somatic embryogenesis)	Firm
<b>Porter's Five Forces</b>		
1. Degree of Rivalry	Low - requires knowledge on gene pathways of selected tree species.	Moderate - many firms exist in the biotechnology and gene mapping industry.
2. Threat of Substitutes	Moderate – natural techniques and field seed selection still exist and while not as timely, still achieve good results.	Moderate – any firm that has the gene mapping sequence knowledge and the biotechnology tools to capitalize on it can create the product.
3. Supplier Power	Low – somatic tissue can be obtained from any selected species stock.	Moderate – research and qualified scientists does not come without high costs.
4. Buyer Power	High – there are few large-scale forestry companies that would be interested in investing their time and resources into this method.	
5. Barriers to Entry	High – would require extensive research into the specific gene pathways of selected tree species. ArborGen™ was fortunate to have their research efforts subsidized by the \$60 million joint venture.	High – would require the data management and DNA and gene mapping technologies in order to produce products.
Opportunities	Opportunities exist with this product in helping forest companies achieve higher growth rates, better quality wood fibre, better seedling establishment rates, and better tolerance to insects, disease and drought. This would mean better quality products for the consumer as well. There are very few, if any, other companies offering this product right now so ArborGen™ has the first-mover advantage. ArborGen™ also already has the knowledge regarding certain gene pathways of commercial trees.	
Threats	Public acceptance and regulatory structures. There is currently no policies regarding biotechnology forestry applications and public concern over environmental contamination and impacts are high. Further to this, regulatory policies and procedures for application have yet to be developed and could impact detrimentally the specific products ArborGen™ is investing knowledge into.	
Internal	Product (Somatic embryogenesis)	Firm
<b>VRIO Framework</b>		
Valuable	The product is valuable to the industry by potentially reducing costs through a faster time to maturity for plantations and a higher grade of wood to market.	Currently, ArborGen™ is the only firm in North America offering this industrial service so their differentiation in the industry is quite high.
Rare	This product is rare in that few firms can implement the technology as it applies to forestry applications and extensive research and knowledge investment would be needed to capitalize on the technology.	Currently, no other firms are producing embryonic products for the forest industry. However, research efforts have not been successful with other species types.
Inimitable	There is no more efficient process for selecting and creating an optimized healthy seedling stock.	Other firms could invest into the knowledge and technology and compete with the same resources.
Organized	This product will help forest companies operating under environmental regulation and monitoring to achieve goals more efficiently and enhance consumer product. It should enhance the operations of most forestry regeneration and harvesting operations.	ArborGen™ was the research arm of a \$60 million joint venture of private industries into tree biotechnology. This has allowed them to create a distinctive knowledge about the genomics of trees. It is utilizing that knowledge in a marketable product with somatic embryogenesis (SE).
Strengths	ArborGen™ has been able to capitalize on the joint venture investment of private industry into industrial application. They have a highly qualified and diverse research staff and state of the art technologies for gene sequencing and trait identification. They have a unique and rare product that has value enhancing implications to the industry. ArborGen's tacit knowledge is one of their strengths.	
Weaknesses	ArborGen™ will find new competition from firms as the technology and knowledge becomes more implicit. It also will need to be able to apply the science to the more commonly used industrial species, which varies internationally. Much more research is needed into the applications of SE on other species. Other more superior germplasms will be the ultimate marketable product once the knowledge is implicit.	

## Strategic Recommendations

ArborGen™ has capitalized on their several advantages with the creation of their products. A \$60 million research project injection from private industry surely helped build the superior germplasms and technology for which their team of scientists could develop. However, in order to become a provider of superior germplasms, one must have superior germplasms. The knowledge of the biotechnology application is merely a toolbox and a means to map and measure characteristics of organisms, specifically trees. ArborGen™ has made significant investments, with its industrial partners, into technology and human capital. ArborGen™ should analyse what market their service is in and what that market will evolve to as research and knowledge is built. Currently, there are no other suppliers of superior germplasms and planting stock for industry. Most planting stock is built from internal nurseries from a selected seed stock built from root cuttings, an often time consuming and not fully effective result. The opportunities and market size is massive if industry and regulators can see the benefits of replanting their managed lands with stock from scrutinized elite germplasms, creating clones of a perfect tree suited ideally for local conditions and yielding better, healthier fibre. ArborGen™ would do well to position itself for this market.

In order to do this, ArborGen™ should focus on:

- Establishing more industry partnerships and industrial projects;
- Ensuring their internal capabilities are maintained as a leading edge research facility focussing on tree species gene mapping;
- Creating and fostering more research partnerships and knowledge transfer with other institutions, primarily university and research firms;
- Ensuring the proper intellectual property mechanisms are in place to protect their investments;
- Enhancing industry and public perception and knowledge about the science in all countries with a managed forest industry;
- Maintaining and acquiring superior germplasms;
- Maintaining a diverse and informed team of staff that help manage and deliver each part of the supply chain.

As ArborGen™ moves more into the market and establishes revenues from its products it will require good industry relationships and name recognition. ArborGen™ has the potential to dominate a large part of the seedling and reforestation market. However before this can be accomplished, the science must prove feasible in all applications and a valuable more robust seedling must be created for low cost for any tree species in any country. ArborGen™ should prove a successful venture if it continues its investments into relationship fostering, technology and knowledge, and superior germplasm stock.

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