

## **Breeding for Competitive Advantage: Program Design in a Vertically Integrated Supply Chain**

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**Abstract:** Design of a breeding program varies based on individual breeder preferences. Given limited resources, design of a breeding program can either enhance or limit capacity, data generation, cycle time from cross to release, success rate and potential value. In a vertically integrated supply chain, with strategic design the focus of a breeding effort can be narrowed to specific needs and results optimized. With respect to barley, such a program exists in Coors Brewing Company's vertically integrated supply chain (VISC) where the breeding program is one of the key components in the overall management of raw material value. Discussed in this presentation will be an overview of the Coors barley supply chain, design of the breeding program, achieved cycle times, execution focus, testing, results and cross-functional coordination.

**Keywords:** Barley Breeding, Supply Chain, Vertical Integration

**Coors Barley Supply Chain Overview:** In 1936 Coors Brewing Company began experimenting with specific malting barley varieties originating from the Moravia region in what is now the Eastern Czech Republic. The logic for this research was simple: high quality malting barley did not exist throughout the Western region of the United States. Bill Coors had the foresight to understand that the future of his brewery hinged on having a consistent supply of high quality malting barley. From this vision, the Barley Program at Coors was born.

The supply chain itself has grown drastically since those early days: however the steps remain amazingly similar. In the current supply chain, traceability and ownership are paramount. The Coors barley production areas cover premier growing regions in Colorado, Montana, Idaho and Wyoming with storage facilities in each area capable of holding the entire contracted crop for that given region. Varieties developed internally by the Global Barley R&D Program are used exclusively by Coors for production. During the production season, growers are continually supported by Coors agronomists who make recommendations on all aspects of production to ensure a crop of the highest possible quality and avoid any regulatory issues. The crop is purchased directly from growers by Coors, with nearly all of the grain stored at a Coors controlled facility in the respective region. A small amount of on-farm storage does occur in certain situations. The barley is then shipped directly to the Coors facility in Golden, Colorado for malting and use in beer production. The only point barley is outside of the Company controlled supply chain occurs during the production season when growers are contracted to produce barley on behalf of Coors.

**Program Design:** Design of a given program can vary as much as the crops breeders are working to improve. Specific to barley breeding programs, design varies from costly molecular approaches to traditional hybridization; from single seed descent to doubled-haploid. Programs can vary from 25 crosses to 10,000 crosses annually with staffing from three to 50 or more. The available options beg the question: with so many approaches (and given the complexity of breeding malting barley) which design is the most cost effective in providing desired results when the genetic improvement is being done for a single

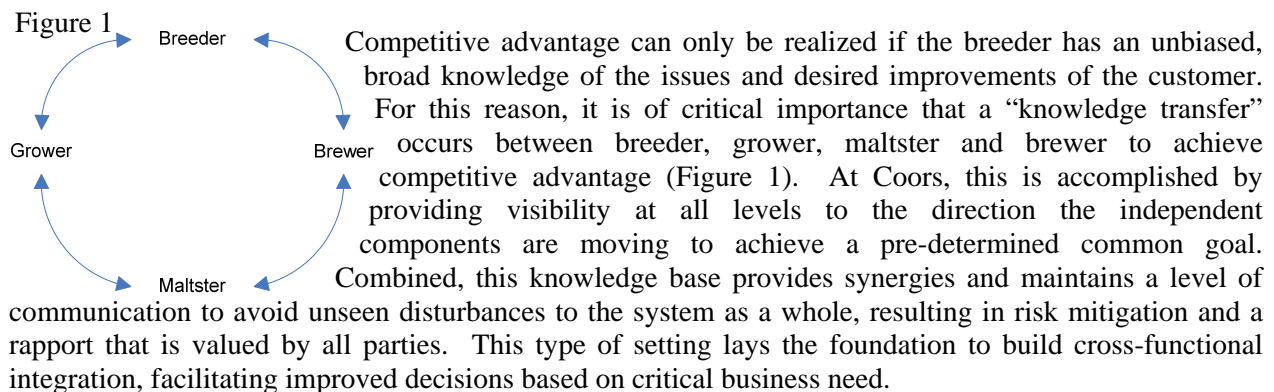
customer such as exists in a VISC? While there are many subgroups that combine to form the whole, three primary components can aid in determining these decisions.

Firstly, even though breeding is dependent upon a broad knowledge of the sciences, in vertical integration we must begin with a very well known marketing adage, “Know Thy Customer.” While this holds true for all breeding programs in the essence that if a breeder doesn’t make improvements growers, maltsters and brewers want, their variety will never reach large scale production. The phrase takes on a new meaning, and becomes increasingly important, when only a single customer exists for your product and that customer relies solely on you to provide it, with new line extensions of increasing quality and value expected at regular intervals.

Secondly, an internal breeding program can only be successful if it has the complete support of stakeholders within a cross-functional setting. A VISC withers, and can become quite costly if we ignore the “integration” component. Success of the entire supply chain balances on how effectively each component functions as a single unit with transparency throughout being essential.

The third component, namely valuation, can only be determined after the previous two are established. The value of specifically desired traits, estimated avoidance of expenditures and potential gains whether in throughput, volume or quality, must be established to effectively breed for competitive advantage. In general, a research and development program contained within a VISC, regardless of discipline, should provide quantifiable value and worth equivalent to a minimum 1.5 fold improvement over the total cost of an R&D program.

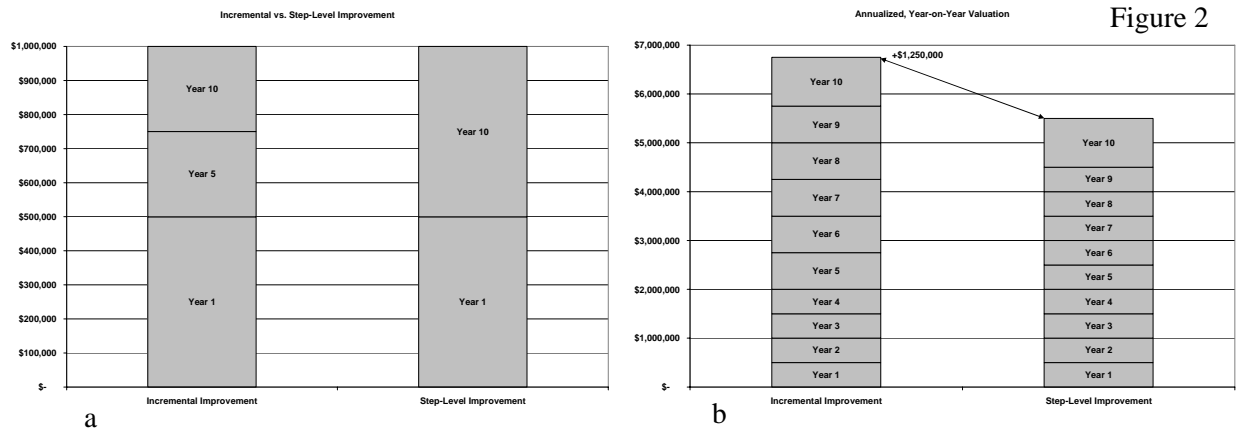
**Know Thy Customer:** Breeders of malting barley typically have many customers throughout the agricultural, malting and brewing industries. It is not uncommon to have a variety, developed on one continent, reach the shores of another and prove to be a successful production variety with near universal acceptance. For this reason, many breeders strive to improve traits that will have wide appeal to the masses, rather than focus on the needs of a single organization and its growers. The opposite of this scenario holds true in a VISC and can work to a breeder’s advantage when designing or changing an existing program.



**Integration:** The next phase in designing a program to function within a VISC is to not only build upon the relationships already made (and complete the integration of the breeding program into the supply chain), but to integrate stakeholders from other facets into the processes of the breeding program. This critical milestone requires that a support structure be built from floor to ceiling within the company’s hierarchy, with the onus on those involved to generate excitement, becoming “data driven salesmen” that are capable of communicating the improvements breeding superior varieties can bring to the company.

Once a rapport has been developed and a few key stakeholders are supportive, a breeding program can say it has been integrated into the VISC. The next and most difficult step to complete the assimilation is to integrate other ancillary stakeholders into the program to complete the assimilation. Varying approaches can be used to accomplish this step, an effective approach used by Coors has been to conduct “Education Days” concurrently with the Field Day events held specifically for growers. Education Days are restricted to internal employees and consist of “hands-on” experiences relative to breeding, planting, selections, harvesting, procurement, storage and quality processes. In addition, several presentations are done throughout the day demonstrating the value of the entire barley supply chain. This type of communication and interaction builds an understanding of the importance and value the barley VISC brings to Coors.

**Valuation:** Determining the value of specific traits may seem a moot point in the grand scheme of large scale VISC. However, when one considers the sum of incremental improvements that can be attained through small enhancements, the increased value can be significant. For example, Figure 2a represents varietal improvements in two scenarios. In this example, incremental improvements over a 10 year span with three variety releases of incremental improvement is compared against a step-level improvement with two variety releases over the same time period. The incremental improvement bar shows that the first variety released in year 1 yielded a value of \$500,000 to the company, with the second in year 5 and third in year 10 both adding \$250,000, totaling \$1 million in value over 10 years. The step-level improvement bar shows that varieties 1 and 2 both added value of \$500,000 in years 1 and 10, respectively, totaling \$1 million. Seemingly the value would be the same, however when we consider the actual incremental impact of these savings (excluding inflation) over the course of the same 10 year span (figure 2b), the simple step of releasing a second and third variety rather than waiting for a step-level improvement results in an added value of \$1.25 million.



Determining the value of specific traits is no simple task and requires input from multiple stakeholders over the course of several years. For this reason knowing what the customer wants, and having support through integration on a long-term basis, are of utmost importance. Traits should then be prioritized by both value and quality attributes, considering the feasibility of successfully breeding for each trait, and then utilized to develop crosses that have the highest potential of increasing value. For example, if elimination of beta-glucans and increasing extract levels will add the most value, then disease resistance or agronomic yield may be a lower priority. This should be reflected in crossing block and program designs.

Including stakeholders in the selection process promotes accountability across the organization and builds confidence that the breeding program is moving in the right direction. For example, at Coors our selection team is comprised of representatives from the five primary organizations within the supply chain that deal with barley; Barley R&D, Brewing Materials, Brewing Services, Malting Operations and Brewing

Operations. Inclusion of all primary components within a VISC facilitates breeding for competitive advantage. Essentially, if all parties possess the same clear and well defined goal (i.e. increasing profitability through reduced COGS and/or increased efficiency), the use of valuation enables straightforward decision making with regard to variety advancement and release. This approach also promotes transparency and makes “hidden agendas” difficult, if not impossible to pose a “road-blocking issue”. Put simply, varieties that are going to add the most value, regardless of where that value is derived from within the supply chain, are advanced.

**Coors Barley Breeding Program Design:** Over the course of the last 70 years, a selection process has been in place at Coors to determine the most appropriate malting barley varieties for use. The processes have ranged from the very simple (involving two individuals) to extraordinarily complex (involving more than 20 employees). The current design enables data gathering at early generations - with several years of multiple site replicated and large scale observation data prior to release, while remaining incredibly flexible in facilitating a variety’s “fast-track” should performance warrant. In addition, the design of the Coors VISC from variety development downstream is capable of utilizing varieties specifically developed for each individual growing region. As a result, the following designs are currently being used independently, but simultaneously, across all current growing regions as well as potential new areas of production.

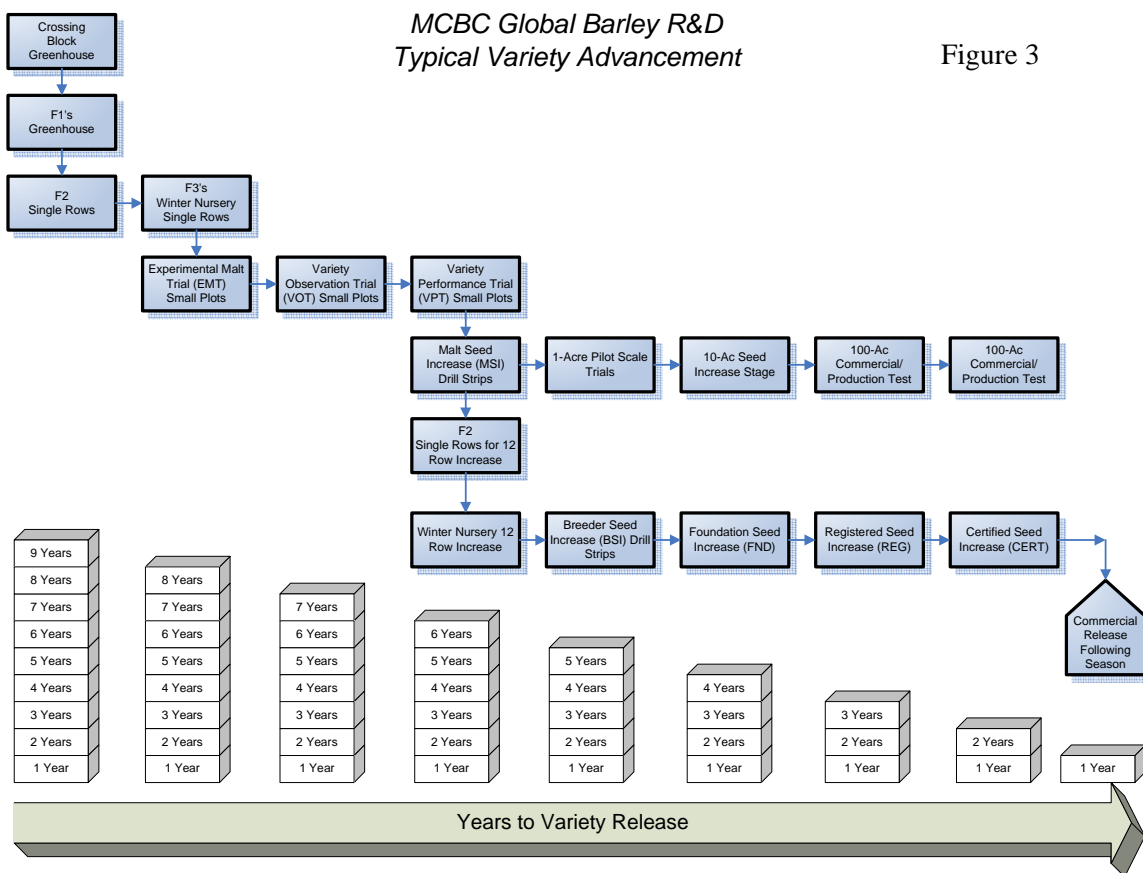
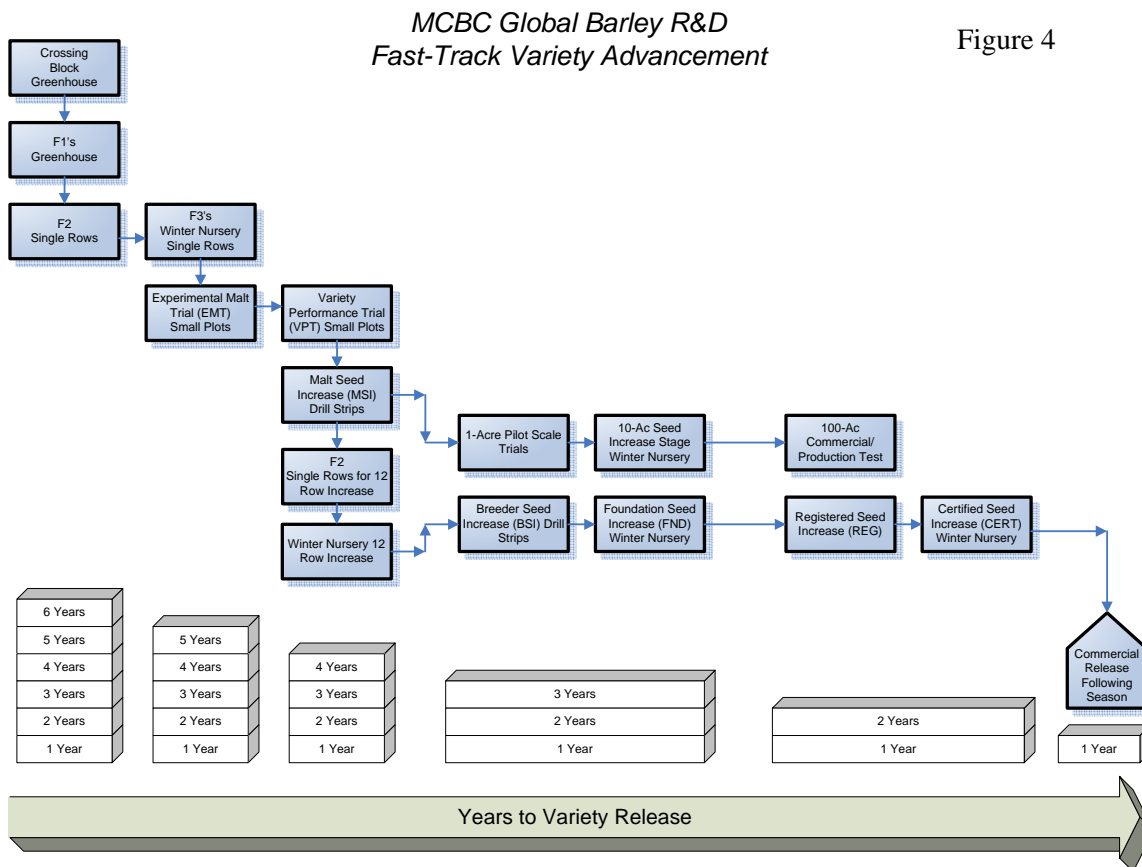


Figure 3 represents a flowchart depicting the typical steps through variety advancement prior to commercial release. In this design, cycle time from cross to variety release ranges from nine to ten years depending on the number of commercial production tests deemed necessary. Within this advancement

track, malting and agronomic data are captured a minimum of seven times over the course of nine years, with six years of multi-site replicated data.



A diagram of the “fast-track” for variety advancement is shown in Figure 4. In this path of advancement data is gathered a minimum of five times over the course of six years with four years of multi-site, replicated data. However in the fast-track approach, the number of large scale observation trials is nearly doubled, enabling field agronomists, R&D staff and growers to gain additional experience with a given variety, making release more feasible.

It is important to note that these two tracks of advancement run simultaneously in the Coors program. At any given time varieties exist in both paths of advancement. What determines the path a variety will take depends on the potential value a given barley can bring to the Company, whether it justifies the additional expense and inherent risk that coinciding with the fast-track approach.

**Variety Comparisons:** Under the current value driven VISC approach and competitive advantage focus, Coors has released one variety with several other potential releases likely to occur in the near future. Moravian 69 was specifically bred for the San Luis Valley growing region in Southern Colorado, replacing the previous line Moravian 14 in 2004. Moravian 69’s cycle time from cross to release was mere six years. Comparative results of five year, replicated data for agronomic and malting quality are shown in Figures 5 and 6, respectively.

As with any variety comparison, there is a trade-off between phenotypic traits. While Moravian 69 has a substantial improvement in yield potential and reduced protein over Moravian 14, it has reduced test weight and plump scores. (percentages shown in Figure 5)

**Agronomic Comparison of Recent Southern Colorado Varieties**

**Figure 5**

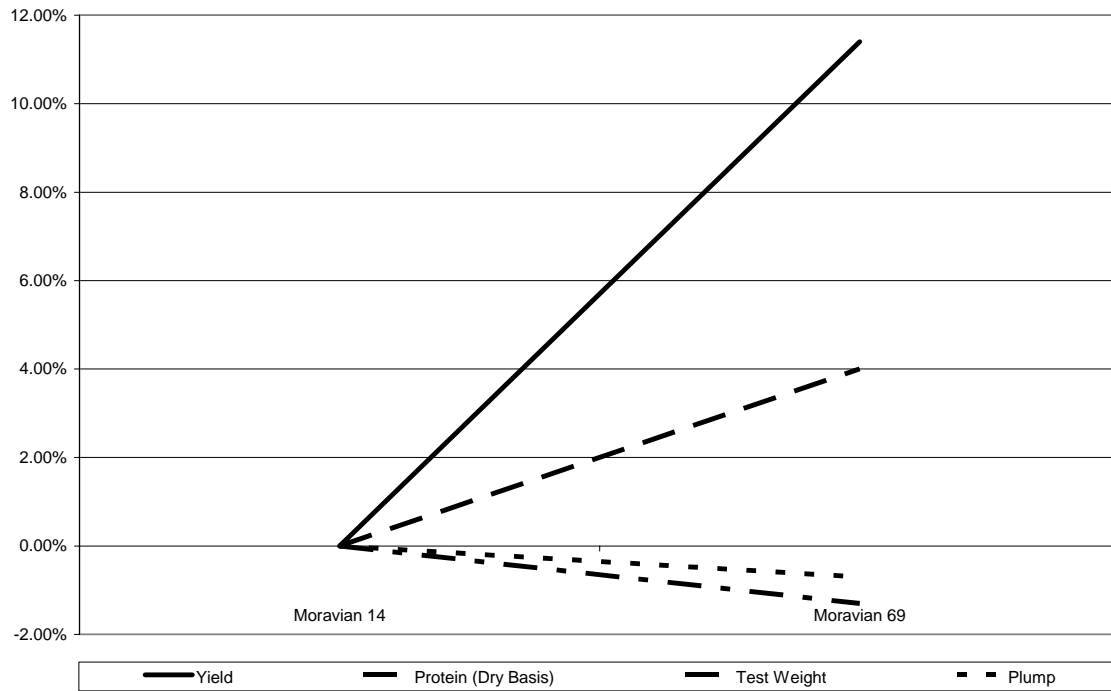
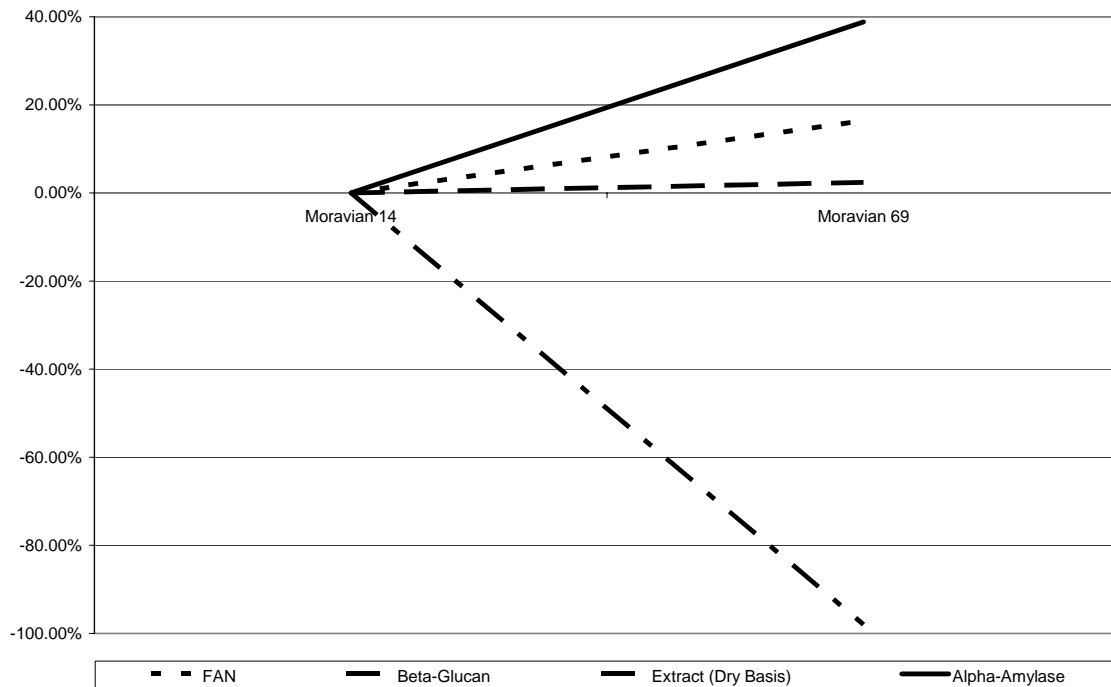


Figure 6 displays a comparison of the malting quality results, using a proprietary malting recipe for varietal comparison. Clear improvements are evident when comparing the two varieties in selected key traits such as extract, FAN, alpha-amylase activity and beta-glucan content.

**Malt Quality Comparison of Recent Southern Colorado Varieties**

**Figure 6**



The compromises made in determining Moravian 69's fate as a commercial release were heavily value driven. While there were substantial trade-offs with the decreased test weight and plump (both contributing to increased logistics and procurement costs), because the value had been determined for each specific trait, an informed decision could be made that resulted in a net positive gain for the VISC as a whole.

**Conclusion and Recommendations:** Should a company determine a vertically integrated supply chain is appropriate for their business strategy, it is critical to understand the parts necessary to drive value. VISC's can be hugely advantageous or extremely costly, if not implemented and managed correctly. With regard to the involvement of a breeding program, the design can and should vary significantly to meet business needs. What works for one, could certainly spell disaster for another.

To avoid such pitfalls it is important to remember the three primary components, namely: know thy customer, integration and valuation. The method to achieve these will depend on the culture of each organization and the individuals at the helm of their respective components within the supply chain. In some companies, they may occur in a different order than presented in this paper - or even simultaneously. The key is that they all happen. Without the benefit of knowing the specific needs of your customer being fully integrated into the supply chain, and understanding the value a breeding program can bring to an organization, it will surely fail.

As in the example from the previous section, one area of a VISC may incur more costs because of a variety release, while another area gains efficiency and subsequent value. What is important to remember is whether or not the net result is positive when considering the VISC as a whole unit rather than individual parts. As such, a VISC should be viewed by management as a *complete* entity rather than simply the sum of various parts. Being a "data driven salesman" facilitates this view by ensuring upper management fully understands what competitive advantages are being achieved, why they are being achieved and where within the VISC value is derived.

Breeding for competitive advantage within a VISC is a difficult process that requires people skills to build relationships as much as it does technical skills. With a common goal at the forefront of each decision and the proper data gained through a specifically designed breeding program, a company can reap the benefits of having a breeding program within their vertically integrated supply chain for raw materials.