



Agbioscience as a Development Driver: Minnesota's Agbioscience Strategy

November 2013



Performed for: AURI (Agricultural Utilization Research Institute)

Performed by: Battelle Technology Partnership Practice

Thanks in part to funding by:

Minnesota Corn Research & Promotion Council

Minnesota Soybean Research & Promotion Council

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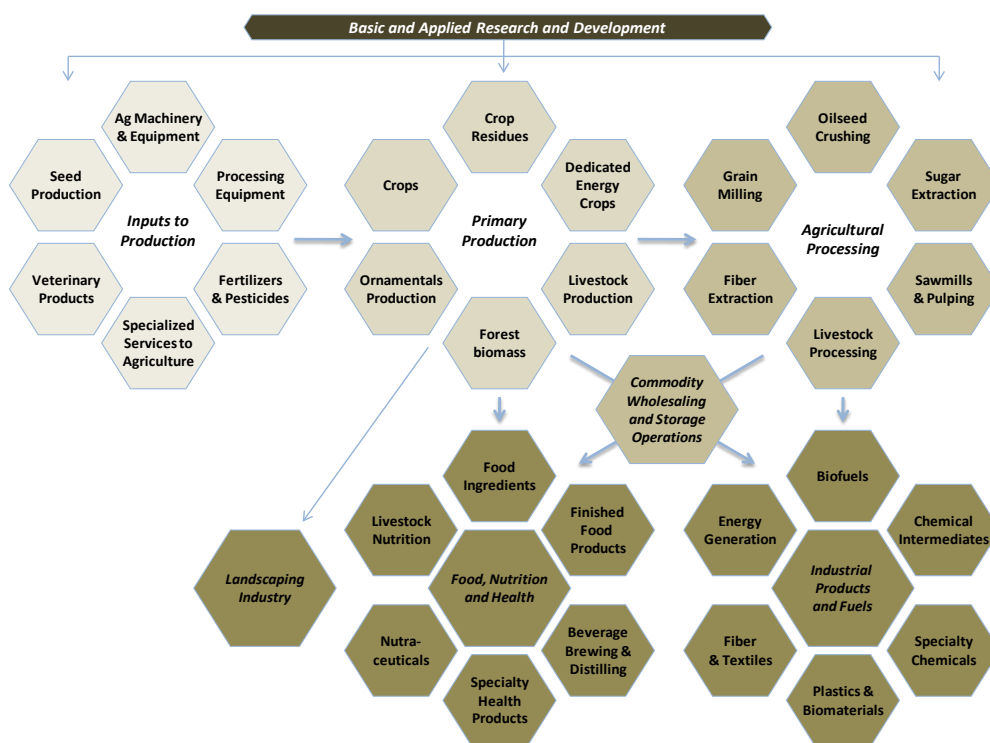
Executive Summary

In today's global knowledge-based economy, competitive advantage is best achieved in an environment that proactively stimulates innovation, knowledge transfer and technology commercialization. Michael Best, a leading scholar of growth and development across regions, notes in *The New Competitive Advantage*:¹

Regions can be thought of as developing specialized and distinctive technology capabilities, which give them unique global market opportunities. The successful pursuit of these market opportunities in turn reinforces and advances their unique technological capabilities. Regional specialization results from cumulative technological capability development and the unique combinations and patterns of intra- and inter-firm dynamics that underlie enterprise and regional specialization.

The U.S. is a global leader in science and innovation related to agriculture and associated biosciences (collectively termed “agbioscience” herein). Within Minnesota, farmers and related industry are engaged in economic activity across this value chain, centered on crop and livestock production, but also including the development of inputs for production (agriculture equipment, seeds, agricultural chemicals, etc.) and the downstream conversion of agricultural products into a wide variety of value-added food, feed, fiber, fuel and industrial biobased products. This diverse and complex value chain, rooted in Minnesota’s highly productive agriculture production system, is illustrated in Figure ES-1:

Figure ES-1: The Minnesota Agbioscience Economy



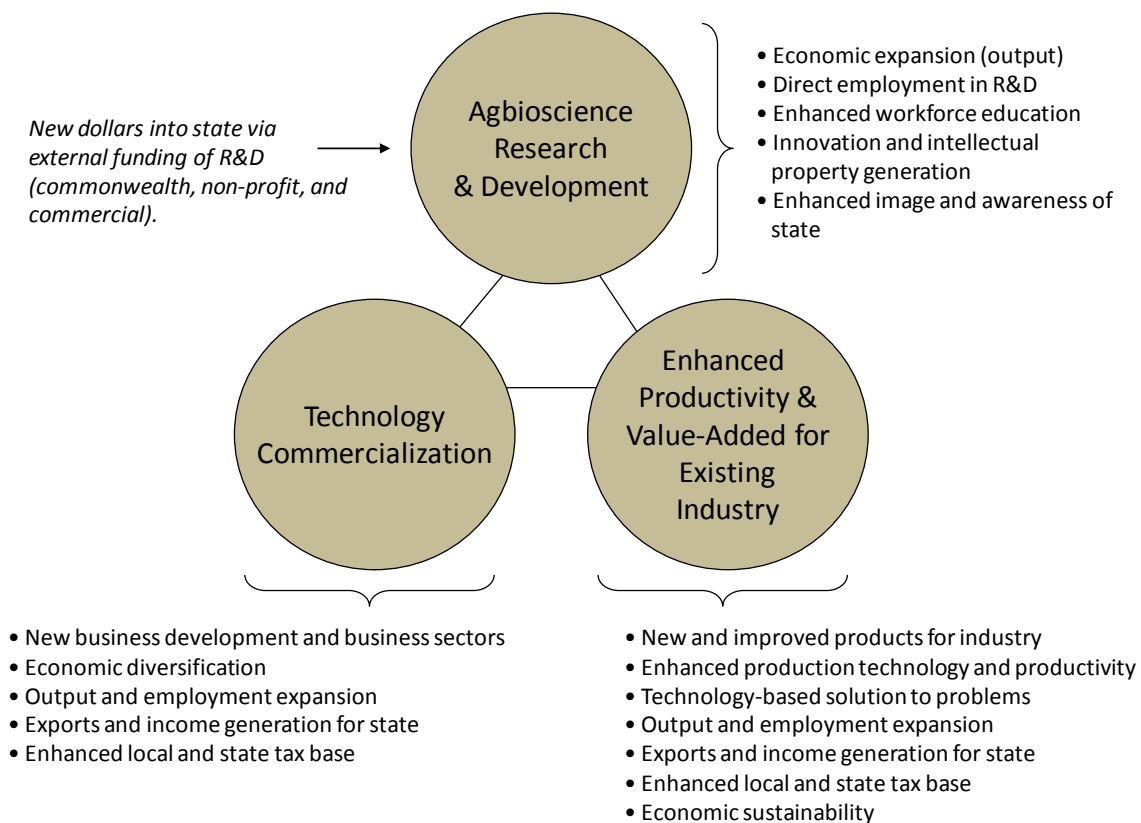
¹ Michael Best. “The New Competitive Advantage: The Renewal of American Industry.” Oxford University Press, 2001.

AURI and other thought leaders within Minnesota recognize that modern agbiosciences represent a powerful tool for economic development along multiple pathways. Through performing and facilitating agbioscience research and development (R&D), working to transfer innovations and know-how into practice, and spurring the development of new and expanded business enterprise, AURI, the University of Minnesota, and other engaged institutions are facilitating:

- An expansion of high-paying jobs in agbioscience R&D and education
- The discovery of innovations to increase agricultural production in Minnesota and the transfer of knowledge and technology to protect and expand the value of agricultural and forest commodities and products
- The development of novel technologies and intellectual property for commercialization by existing or new business entities
- The diversification of the Minnesota economy into new industries that leverage biomass and biobased inputs for industrial applications.

Figure ES-2 illustrates the key economic benefits associated with the State of Minnesota's investment in AURI and other core R&D and agbioscience development assets in the state.

Figure ES-2: Economic Development Benefits Associated with Agbioscience Development



Recognizing the diversity and potential scale of economic opportunities associated with agbiosciences, AURI determined that the next phase of agbioscience-based economic development in Minnesota would benefit from having a formal assessment of agbioscience R&D core competencies performed. Having an in-depth understanding of R&D core competencies and assets will help AURI identify and understand established and emerging platforms of technologies and capabilities that could form the future launch pads for further advanced agbioscience-based economic development in Minnesota. AURI approached the Battelle's science and technology-based economic development consulting group, the Technology Partnership Practice (TPP), to:

- Undertake a quantitative and qualitative evaluation of established and emerging agbioscience core competencies in Minnesota to identify established and emerging platforms for Minnesota agbioscience-based economic development
- Develop a strategy and action plan to guide key actions and investments for agbioscience-based development in Minnesota.

This report is focused on how to help ensure that a historic industrial anchor for Minnesota, the agbiosciences, also offers outstanding growth opportunities for the future. This report addresses how industrial and academic partners might better align around the key technology platforms represented in their respective spheres, which in turn will lead to globally competitive agbioscience R&D, its commercialization, and the subsequent creation of high-paying jobs for Minnesota citizens across the entire state.

Minnesota's Agbioscience Technology Platforms

Minnesota enjoys a diversity of agbioscience R&D core competencies that represents the foundation of know-how upon which Minnesota can continue to support agbioscience innovation and generate new businesses, economic expansion, and jobs. However, individual core competencies are not sufficient to support agbioscience innovation and spur growing and emerging markets. Increasingly, agbioscience innovation requires going beyond single disciplines through transdisciplinary approaches that explore the interfaces and merge boundaries of multiple fields of research in order to solve increasingly complex problems. To maximize the development potential of its agbioscience core competencies, Minnesota needs to consider how these core competencies can be integrated into broader strategic technology platforms to serve growing and emerging market opportunities.

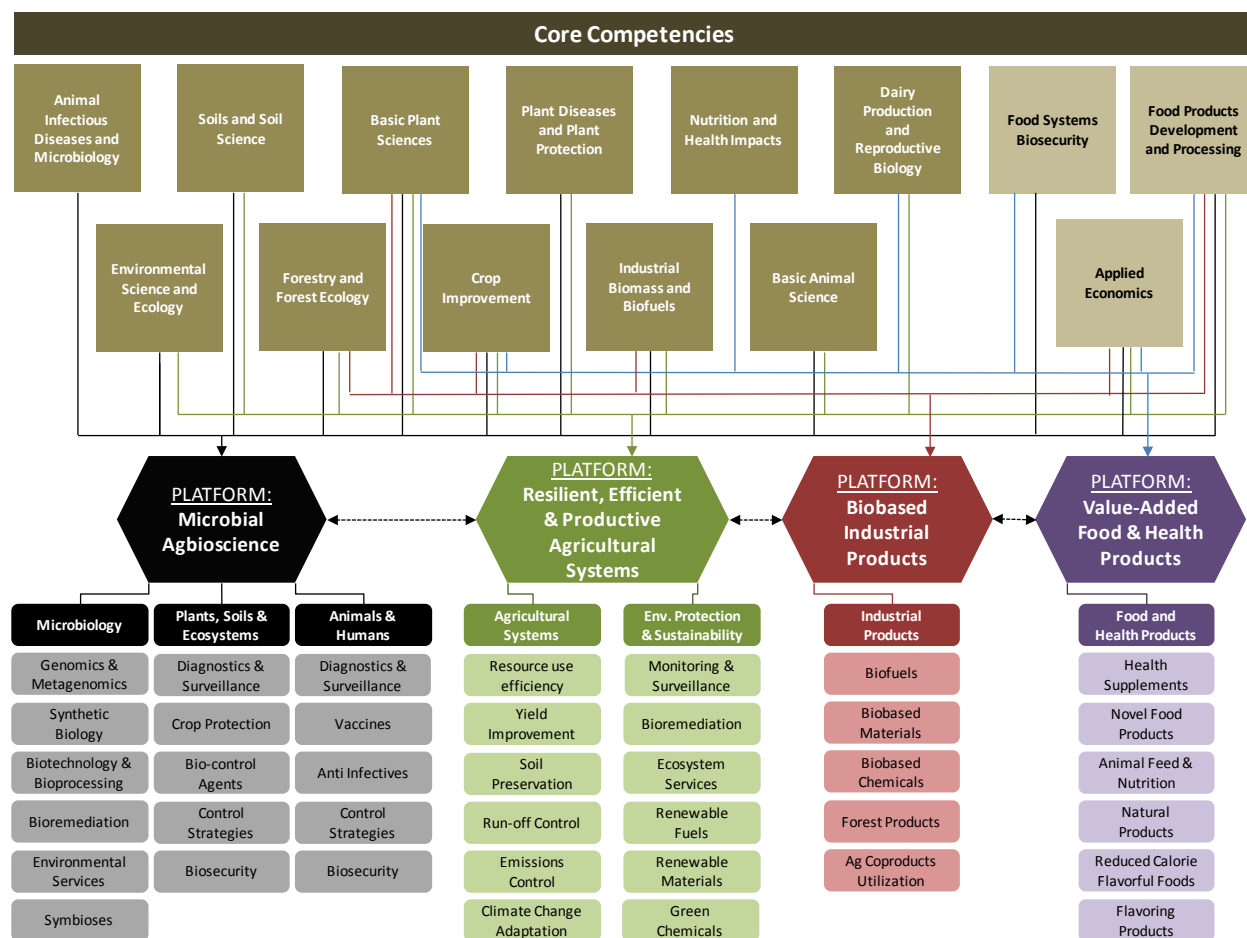
In the case for Minnesota, it is evident that four major agbioscience platforms (Table ES-1) can leverage the majority of Minnesota's agbioscience and associated core competencies.

Table ES-1: Recommended Minnesota Agbioscience Development Platforms

Platform	Primary Focus	Applications
Microbial Agbioscience	Utilizes the broad and deep microbiology, genomics, ecological science, infectious disease (plant, animal, human), biosecurity and other related areas of expertise to undertake transdisciplinary studies and promote innovation to combat agricultural and zoonotic pathogens and to utilize microbes and microbial communities to accomplish economic functions.	• Identification and characterization of pathogenic organisms • Identification, characterization and modification of organisms for biotechnology and bioremediation applications • Diagnostics, sensors, monitoring and surveillance technologies • Anti-infective agents and vaccines • Disease resistant agricultural crops • Organisms for bio-control applications and industrial applications (natural, genetically modified, or synthetic) • Inoculants and microbial ecologies for soil enhancement or growing media
Resilient, Efficient & Productive Agricultural Systems	Utilizes the outstanding ecological and environmental science research capacity in Minnesota, in combination with agriculture and agricultural systems expertise, to develop new and novel approaches and technologies for sustainable agricultural production for Minnesota and the world.	• Crops efficient in the use of inputs and natural resources • Technologies to increase agricultural yield • Soil preservation of agronomic land, and strategies for improvement of marginal soils • Methods and technologies to reduce or eliminate run-off of chemicals and manure from agricultural operations • Control of emissions from agriculture • Adaptation of agricultural systems, crops and livestock to climate variability and climate change • Systems for sensing and monitoring agriculture and forestry related pollutants and emissions • Bioremediation technologies for agriculture applications • Quantification and valuation strategies for ecosystem services • Application of biomass and biobased resources to renewable energy and other sustainable industrial applications in materials and chemicals
Biobased Industrial Products	Researching, developing and evaluating potential industrial biobased products (biofuels, materials, chemicals and value-added forest products) that are produced from farm and forestry outputs. Feedstocks may comprise primary agricultural and forestry crops, newly developed or enhanced crops, and value-added utilization of agriculture and forestry coproducts, and coproducts generated from downstream value-added industrial and food processing.	• Biofuels from primary agriculture/forestry output and coproducts/waste-streams • Biobased materials and composite structural products • Green chemicals and biobased chemicals and polymers
Value-Added Food and Health Products	Researching, developing and evaluating advanced nutrition and health products that are produced from farm and forestry outputs. Feedstocks may comprise primary agricultural and forestry crops, newly developed or enhanced crops, and value-added utilization of agriculture and forestry coproducts, and coproducts generated from downstream value-added industrial and food processing.	• Identification and characterization of functional phytochemicals and natural products with health promotion activity • Development of advanced and functional food products • Development of value-added agricultural product-based health supplements • Enhanced animal feed/nutrition products • Reduced calorie foods with enhanced flavor/sensory characteristics • Flavoring products

Multiple identified core competencies connect to each of these four platforms. Connections are illustrated in Figure ES-3, together with functional R&D and associated opportunity areas associated with each platform.

Figure ES-3: Core Competencies, Associated Platforms, and Opportunities



Advancing Development Plans for Targeted Agbioscience Technology Platforms

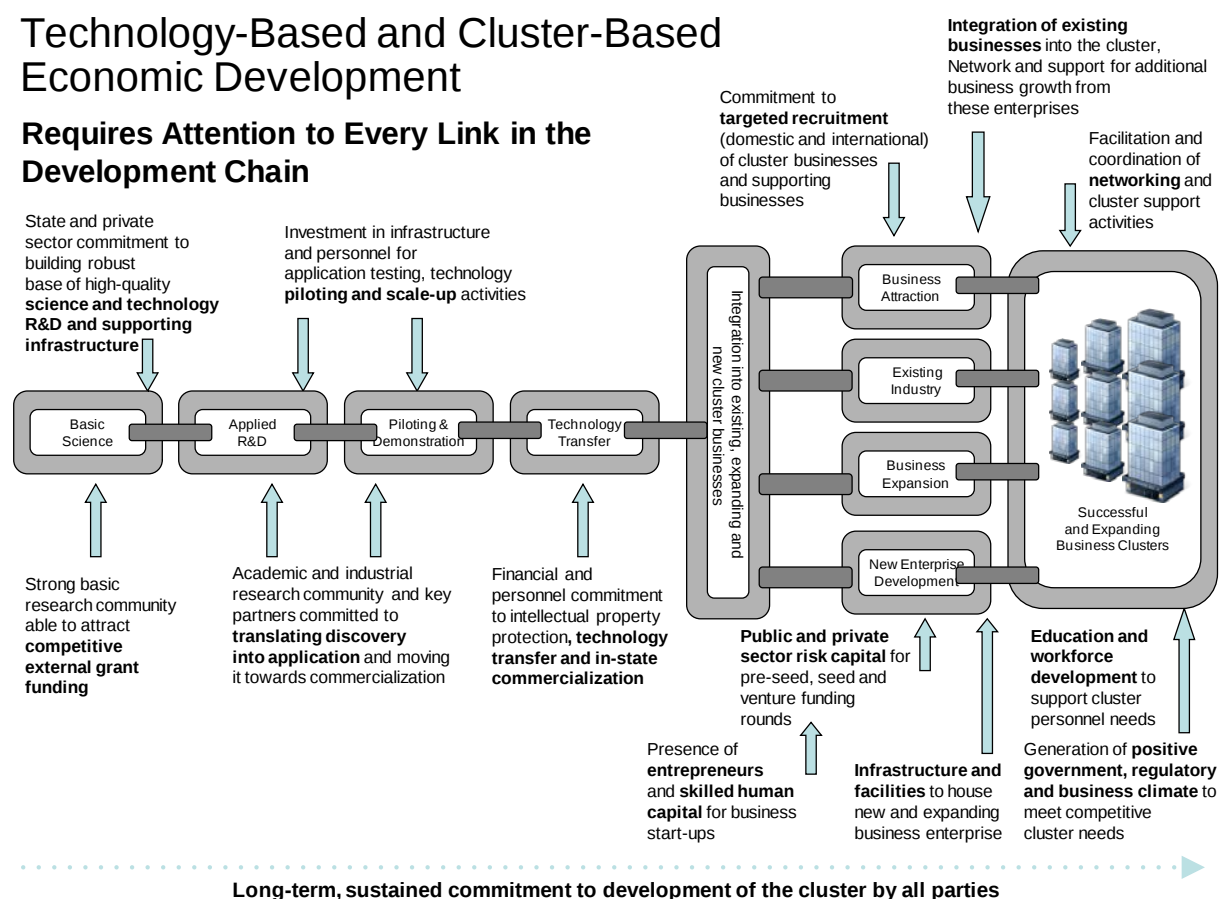
The identification of the four agbioscience technology platforms for Minnesota is not an end in itself, but rather a starting point for Minnesota to move ahead in overall agbioscience development. These agbioscience technology platforms align with the specific research core competencies found across industry and research institutions in Minnesota and have the potential to lead to products in new markets. In order for Minnesota to realize the potential of these technology platforms, it is essential to advance bold but also realistic development plans that incorporate “outside the box” thinking about how best to create the strong, systematic linkages across Minnesota’s industry and academic enterprises to ensure Minnesota is taking advantage of its agbioscience technology capabilities to remain strong in both its academic and industry settings.

It is important to recognize that for agbioscience economic development to occur at all, an entire interconnected sequence of positive factors, or what Battelle terms a “commercialization chain” or “innovation ecosystem”, has to be in place that connects and strengthens the drivers of innovation and industry development, namely technology, talent and capital. If links in the commercialization chain either inadequately address economic needs or are missing altogether, a sustainable technology cluster able to generate quality jobs is unlikely to develop (see Figure ES-4).

Figure ES-4: Technology-Based Commercialization Chain

Technology-Based and Cluster-Based Economic Development

Requires Attention to Every Link in the Development Chain



A key mechanism for unlocking the full potential of a state’s research assets is to advance technology commercialization activities that are involved in enterprise development and support. This includes conducting due diligence, business planning, mentoring and coaching, pre-seed to seed and later stage risk capital financing, and a serial entrepreneurial talent pool to create, grow and attract businesses.

Critical components within such an innovation system include developing programmatic initiatives that:

- Accelerate the commercialization of university-developed technologies

- Foster value-added private sector/academic collaborations that focus on transdisciplinary, applied research that solves key agricultural production and related industrial needs
- Provide in-depth support at all stages of the enterprise creation and business launch cycle.
- Offer an integrated system for multi-use facilities and shared-use equipment targeted to scaling technology companies
- Address the need for risk capital at all stages of the technology development and commercialization life cycle. An even more critical element given the ongoing global risk capital shortages.

The end goal for a Minnesota Agbioscience Strategy is to create an environment in which:

- Cutting-edge, commercially-relevant agbioscience research leads to applied technologies and product innovations that have commercial application within key agbioscience technology platforms and industry sectors of Minnesota
- Technological advancements quickly make their way into the hands of entrepreneurs and industry leaders who create new products, form new agbioscience companies, or transfer the technology to existing Minnesota agbioscience companies
- Agbioscience companies are able to secure the needed resources to move innovative products into the market place with the support of outstanding supply chain partners, expert management teams, and sufficient financial capital
- Existing agbioscience industry clusters are supported and emerging clusters are formed as a result of Minnesota's technological strengths thereby creating global comparative advantage as a result of the mutual proximity, connections, and shared specialized infrastructure, labor markets and services.

A set of common challenges and imperatives has emerged across the four agbioscience technology platforms regarding the “missing links” in the commercialization chain that are holding Minnesota back from reaching its full agbioscience development potential. The common challenges center around four main needs:

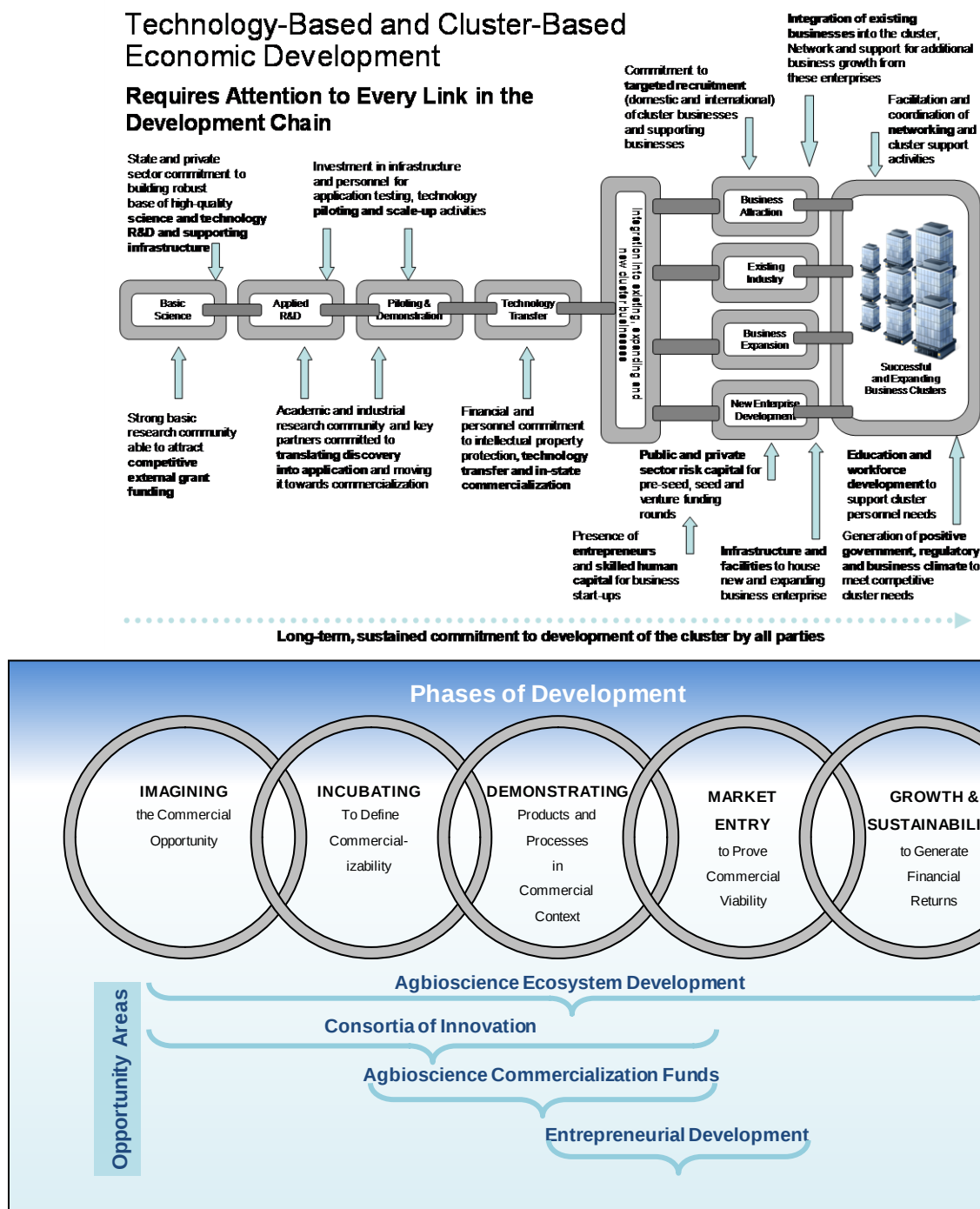
- Academic research efforts that are applied in nature, transdisciplinary in focus to adequately cover the complexity of the technology platforms, and designed to meet present and future agricultural production and related-industrial needs
- Commercialization focus that brings new products to market to increase the global competitiveness of Minnesota's private sector around each of the technology platforms
- Entrepreneurial ecosystem that addresses both the lack of human capital (entrepreneurial management talent) as well as risk capital
- Strategic partnership/networks that address broad, transformative technology platform issues.

To address these common challenges, a continuum of actions/initiatives is presented that are designed to advance agbioscience development by focusing on four cross-cutting areas of opportunity:

- **Opportunity 1:** Form Cluster Networks around the identified agbioscience technology platforms to foster strategic partnering to tackle broad transformative initiatives
- **Opportunity 2:** Establish competitively designated Consortia of Innovation around Minnesota's four identified agbioscience technology platforms
- **Opportunity 3:** Build upon Minnesota's existing commercialization funds to support proof of concept and commercialization activities in order to advance technologies related to the four identified agbioscience technology platforms
- **Opportunity 4:** Design and sustain a robust, agbioscience-specific, entrepreneurial ecosystem to build a stronger, indigenous industry base in Minnesota around the four agbioscience technology platforms.

These four areas of opportunity, if implemented, will reach across the five phases of agbioscience development to help create a robust innovation ecosystem in which the agbioscience industry can thrive and flourish in Minnesota. Figure ES-5 depicts graphically where each opportunity area falls within the phases of development, and therefore what functions those efforts must seek to fulfill within the commercialization chain.

Figure ES-5: Minnesota's Agbioscience Development Strategy

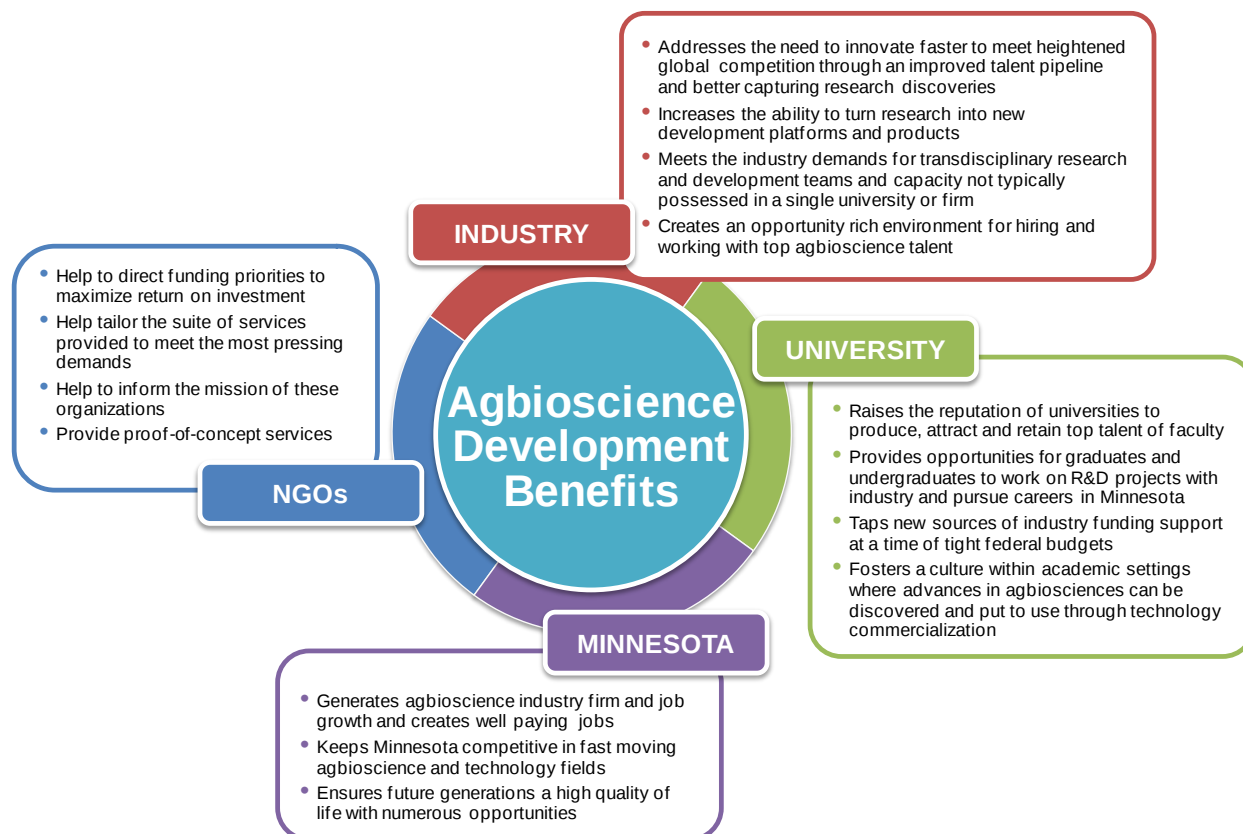


Conclusion

To advance the agbioscience sector in Minnesota, it is critical to further public-private partnerships that align the needs of the agbioscience industry with university research core competencies to foster technology commercialization and new product development efforts. In this way, Minnesota's agbioscience sector will be better able to take advantage of growing and emerging global market opportunities. The pace of such public-private partnerships is rapidly accelerating as the agbioscience sector looks to share with outside partners even more of the R&D burden (and risk) in the face of global competition and industrial challenges. For the private sector, this development has resulted in more open innovation approaches that tap the ideas and capabilities of others rather than solely relying on internal research programs for innovation and new product development.

The Agbioscience Development Strategy laid out in this report provides the rationale for the development of four technology platforms that are critical for the future growth of Minnesota's agbioscience industry. The benefits of the agbioscience development strategy to industry, universities, non-governmental organizations (NGOs), state government and other key stakeholders are summarized in Figure ES-6.

Figure ES-6: Benefits of the Agbioscience Development Strategy to Industry, Universities, NGOs, and the State of Minnesota



By aligning with and implementing this strategy, Minnesota, based on its globally competitive and unique assets, has the opportunity to incentivize agbioscience development across the state. It is

important to note, however, that Minnesota's is not alone. Numerous competitors across the nation and around the world see similar opportunities and are investing significant resources to realize economic gains. Implementing this strategy is an effort that Minnesota must engage in if it wishes to maintain and further develop its global strengths in the agbiosciences and realize subsequent economic impacts.