Defining Progress and Potential: An Assessment of the AgTech Industry in Georgia

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Executive Summary

The University of Georgia Center for Agribusiness and Economic Development (CAED) partnered with the Georgia Department of Economic Development's Center of Innovation (COI) to assess the Agricultural Technology (AgTech) industry in Georgia. The assessment included objectives designed to define activities and business types within AgTech, measure the related economic metrics, and build upon these to help quantify the economic footprint of this evolving and strategic sector.

Despite challenges of imprecise working definitions and the vast diversity of products and services, the CAED team provides guidance for using the North American Industry Classification System (NAICS) as a step forward in measuring the size, scope and potential of the AgTech Industry in Georgia.

Highlights include:

- Thirteen primary NAICS codes are identified as relevant for classifying the AgTech sector, forming the basis for gauging the economic importance to Georgia.
- Key metrics for these broad categories include nearly $51.6 billion in annual sales from 28,944 business establishments employing 213,810 Georgians.
- A purely NAICS-based approach does not perfectly reflect AgTech today, so options for other classification schemes are explored.
- Adoption of a dynamically revisable AgTech definition, in-depth exploration of business groupings to further isolate relevant activities, and consistent gathering of AgTech business intelligence provide a framework for monitoring the industry into the future.
- Case studies documenting AgTech success offer a valuable supplement to the quantitative approach.

The accelerating nature of AgTech makes this CAED report a necessarily brief snapshot in time. The exciting pace of AgTech and its promise for Georgia's economy necessitates an ongoing quest for accurate evaluation. CAED looks forward to a continuing partnership with COI to build on this foundational work in pinpointing the importance of AgTech to the Georgia economy.

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Defining Progress and Potential: An Assessment of the AgTech Industry in Georgia

Introduction

The University of Georgia Center for Agribusiness and Economic Development (CAED) partnered with the Georgia Department of Economic Development's Center of Innovation (COI) to assess the Agricultural Technology (AgTech) industry in Georgia. This industry is strategic for our state. While the COI exists to help all the state's businesses clear the path to innovation and growth, it offers laser-focused expertise in strategic industries that include AgTech. COI specializes in forward-thinking solutions that keep Georgia companies thriving and advancing in a rapidly changing world economy, and its priorities for AgTech support shaped this study.

The objectives included:

- **Define.** Identify activities and business types of the AgTech industry, reviewing data to synthesize definitions and develop criteria for categorizing enterprises under the North American Industry Classification System (NAICS). NAICS is a standard method for classifying business establishments, typically used by federal statistical agencies.[1]
- **Measure.** Compile and analyze key economic metrics describing the AgTech industry in Georgia that relate to the defined activities and business types.
- **Build.** Apply these definitions to construct the economic footprint of the AgTech industry and supporting sectors, and set a path for continued information gathering.

The CAED team clarified the working definition of the AgTech industry, building an economic profile to describe it and establishing a framework for continuing to track it. The study recognized and leveraged CAED's expertise through the combined missions of research and extension. CAED economists and business specialists use their knowledge and skills to add value to Georgia's agricultural economy and help individuals succeed in agribusiness.

Background: The Promise of AgTech and Georgia's Related Priorities

Despite 18th century Malthusian predictions that food supply cannot keep up with increasing population (Malthus, 1798), food production grew remarkably in recent decades, with per capita agricultural production exceeding population growth (Pretty and Bharucha, 2014).[2] However, the available land for producing food is expected to lag far behind the demand for food globally, which increases the value of AgTech advancements that can mean better tools and practices to transform agricultural processes, increasing production and potentially reducing costs.

"*AgTech describes innovative technologies in the agricultural sector that demonstrably enhance the sustainability of the practice by increasing productivity, improving the efficiency of resource use, and*

[1] For more details about NAICS, see https://www.census.gov/naics/, Note that there are upcoming revisions for the 2022 version, to be released January 2022.

[2] See Pretty & Bharucha (2014) for an in-depth history of world agriculture trends.

reducing ecological impact. They also yield sustained or enhanced profitability to investors by increasing the long-term value of ag production." (Dutia, 2014, p. 172).

The AgTech industry is defined in a variety of ways, depending on the information source, and generally refers to technology-based products, applications, and innovations. These are developed for, and used by, agriculture production (and related) businesses spanning the agricultural value chain. From physical inputs to the end user, the ag value chain features technology, crop production, animal production, agricultural processing, manufacturing and distribution, and consumer consumption of the resulting food, fiber, and energy products (Dutia 2014). (See Figure 1.)

Within these ag value chain categories, COI leadership highlighted the following four priorities related to AgTech in Georgia:[3]

- *Within technology inputs*, COI priority is integrated precision agriculture, which utilizes technology developments to help farmers become more efficient by reducing costs and increasing yields.
- *Within crop production*, COI priority is Controlled Environment Agriculture (CEA), which produces locally sourced, year-round fruits and vegetables through technological advances in greenhouse and indoor warehouse operations, growing techniques, lighting systems, and automated processes.
- *Within agricultural processing*, COI priority is food product innovation that leverages the state's diverse agricultural commodities to generate additional revenue sources and create jobs.
- *Within manufacturing and distribution*, COI priority is food system technology integration that allows companies to be more efficient and provide a safer product to consumers, all by increasing technology through the food system supply chain.

While the four priorities appear separate, in reality they are close and even intersecting because AgTech is a dynamic, rapidly changing industry. Advances may arise from diverse segments of the value chain, developed by both established enterprises and entrepreneurs (Dutia, 2014). In Georgia, agriculture and technology are large economic sectors that often overlap. "*The latest advancements in technology can be thought of as bringing agriculture from the Industrial Age into the Digital Age*," COI mentions on its website. Along with great potential for economic impact in Georgia, the dynamic nature of AgTech poses challenges for methods typically used in economic studies like this one.

[3] https://www.georgia.org/center-of-innovation/areas-of-expertise/agtech

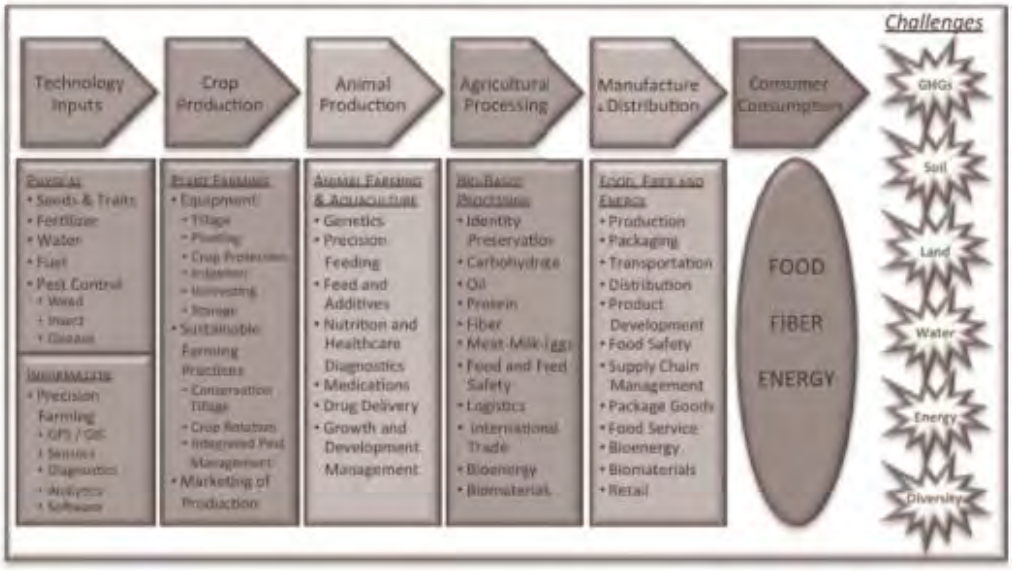

Figure 1. The AgTech Value Chain (Dutia, 2014, p. 174)

The Big Picture: Economic Importance of Agriculture and Technology

The agricultural value chain crosses many dimensions, offering sustenance to the world's people and significant financial gain to the producers of related goods and services and the economies supporting them—local, state, regional, and national. Agriculture and related industries account for more than 10 percent of U.S. full- and part-time jobs (USDA ERS, 2021) and more than five percent of value added to gross domestic product (USDA ERS, 2019), from the perspective of farm production to the final consumer (USDA 2020).

In Georgia, recent figures point to agriculture's economic footprint of over $70 billion. This industry supports more than 359,000 jobs (when inputs including food and fiber production, and select agricultural processing, are included). These figures cover agriculture's supporting industries across the economy, and economic activity resulting from employees working and living in local communities (CAED, 2021). Its large, diverse economic presence makes Georgia agriculture attractive for technology innovations throughout the value chain. In general, most industry sectors have experienced technological enhancements that dramatically alter economic interactions, leading to new products and businesses. This great change from technology means great diligence is needed to accurately capture economic value.

In response, the U.S. Bureau of Economic Analysis (BEA) improved measures of the digital portion of the economy—high-tech goods and services. To better describe these contributions to the economy, the BEA isolated the measurements of the digital economy, and estimates that the total accounts for 9.6 percent ($3,167.3 billion) of current dollar gross output (2019) of the U.S. economy. This includes digital infrastructure, e-commerce, and priced digital service, and represents a doubling (in 2019 dollars) of this industry since 2005. The BEA analysis demonstrated that while overall U.S. economic growth was at 1.9 percent, the digital economy was growing at a rate of 6.5 percent.

To be clear, the BEA measurements do not tell us how much of the digital economy is dedicated to AgTech or specific to Georgia. Through the national context, we understand the growing importance of high-tech goods and services, which rank fourth highest as a share of the GDP (U.S. BEA, 2021).[4] For the global context, we turn to research by McKinsey & Company, which found that a well-executed connectivity effort in agriculture could increase worldwide GDP by as much as $500 billion annually by the end of this decade, with most of that increase taking place in North America (Goedde et al., 2020) . Another source predicts that AgTech will grow an average of 150 percent each year from 2020 to 2025 (Juniper Research, 2021). These statistics point out the magnitude of agriculture and technology becoming intertwined, and underscore the value of ongoing efforts like ours in Georgia to effectively understand and portray this synergy.

Defining AgTech: New Challenges, New Methods

A typical assessment of an industry would begin with the NAICS classification code that defines the type of business. NAICS is the workhorse for industry definitions, providing consistent classifications and underpinnings for federal statistical data collection and providing the foundation for numerous private sources of business data. The next step would be to collect the latest figures on significant metrics such as employment or annual revenue for the NAICS-identified sectors. Finally, we would employ data analysis ranging from simple frequencies to more advanced statistical modeling to reveal the ultimate conclusions.

The complexity of the AgTech industry prevents this precise approach. First, there is no single NAICS code or family of codes[5] that fully represent AgTech enterprises. NAICS classifies businesses upon a "production-oriented concept" (census.gov) according to the processes involved in creating their final product or service. In AgTech, the technology products, services, or applications relevant to agriculture could come from—or be introduced to market by—a number of business types. For example, indoor farming operations may be grouped together, but not categorized by the specific technology used to produce the crop. While some of the NAICS system is being revised, our review of these changes does not reveal an appropriate category for AgTech businesses.

Second, many technologies used across the AgTech value chain are produced or offered by a specific business type that also serves other industries, but does not break down its data by market. NAICS 511210, Software Publishers, is one example. This categorization does not capture sales to agriculture businesses, or delineate the software publishers that may be considered AgTech enterprises. Further, some businesses are quite integrated into different lines of work, horizontally or vertically, such that their status in AgTech could be miscategorized. For example, a manufacturer of agricultural equipment might have a range of NAICS codes related to their business entity type, from manufacturing to farm management services to technology products and services. Under NAICS, this company might still be primarily classified as a manufacturer—not simply a provider of agricultural technology products or services.

[4] Contacts at the BEA indicated that they do accept comments and suggestions that may work to enhance their estimates. Note that in email correspondence, they indicated that these figures do not exist specifically for AgTech or Georgia but that they are willing to consider any suggestions for improving their tools.

[5] Or Standard Industrial Classification (SIC) code.

A final challenge for a full assessment of the AgTech industry is varying definitions. Because of AgTech's fast-paced evolution, dynamic definitions are expected. AgTech, however, is more than a business type; it involves a wide spectrum of product lines with customers all along the ag value chain. AgTech needs an accurate placement within the NAICS classification system to produce useful statistical data sets, which leads us to provide this guidance: moving AgTech under particular NAICS industries will help us begin to accurately gauge its presence and importance to Georgia in economic terms.

Based on discussions with COI, further analysis based on secondary data analysis, and a series of interviews with experts, the CAED moved forward in obtaining AgTech industry metrics. CAED collected data and used NAICS classifications in this manner:

- Analyzed names of known players in the AgTech space, not limited to any particular segment of the value chain. Matching these names to public and subscription business data sources, CAED obtained the reported primary NAICS code.[6] AgTech, by its very nature, is not limited geographically, so our initial search is not constrained to Georgia; the first cut of applicable NAICS code information was the entire nation.
- Analyzed names of known players in reported AgTech venture capital deals and gathered business data from news releases and summaries about these firms. Used the names of these firms to obtain the reported primary NAICS code of each.

The resulting list of potential NAICS codes offer a broad view of those which may contain AgTech businesses, based on the self-reported NAICS codes of select Georgia and U.S. businesses identified by multiple sources. Before getting into the specific results, we need to point out two important caveats.

First, because the scope of this project did not extend to individual verification of each firm and related activities, the following categories may be considered an umbrella for important metrics for AgTech economic activities in Georgia.

Second, from selected NAICS categories among U.S. enterprises, we obtained and analyzed business demographic data for Georgia. Because we cannot specifically segregate which are AgTech, the figures are given as an indication under which industry size and scope may fall and not a precise measure of the current status. While the findings resemble a heat map more than an exhaustive list, this provides a step forward[7] to measure the size, scope and potential of the AgTech Industry in Georgia.

[6] Because NAICS codes are self-reported by business entities, there appear to be discrepancies and/or inconsistencies between the codes and apparent business activities and between sources. Further, many businesses appeared simply as unclassified establishments. Our search was narrowed down to primary NAICS, though some firms had many listed, depending upon source. We use the 6-digit code when available for consistency. According to the U.S. Census Bureau, "A complete and valid NAICS code contains six digits" https://www.census.gov/naics/#q5.

[7] CAED also explored the options of reviewing Product Line detail as part of Economic Census data as well as the newly introduced North American Product Classification System (NAPCS), but neither provided detail sufficient for the classification required. See census.gov for more detail about these systems.

Our AgTech Industry Assessment

Identifying Relevant Sectors

The following NAICS codes will help define the AgTech industry in Georgia, and are listed with examples of products and services of relevant businesses. Note the overlap: businesses producing the same product are sometimes listed in multiple NAICS codes. This duplication likely results from inherent errors in businesses' self-identification, database misclassification, or searches by primary NAICS code when some enterprises use two or more.

Crop Production

NAICS code 111419 - Other Food Crops Grown Under Cover comprise businesses that primarily grow food crops (except mushrooms) under glass or protective cover. *[Examples: holistic indoor farming, greenhouse vegetables, shipping container-based farms]*
NAICS code 111998 - Other Miscellaneous Crops comprise businesses that primarily engaged in growing crops (except oilseeds and/or grains; vegetables and/or melons; fruits and/or tree nuts; greenhouse, nursery, and/or floriculture products; tobacco; cotton; sugarcane; hay; sugar beets; or peanuts); growing a combination of crops (except a combination of oilseed(s) and grain(s); and a combination of fruit(s) and tree nut(s)) with no one crop or family of crops accounting for one-half of the establishment's agricultural production (i.e., value of crops for market); or gathering tea or maple sap. *[Examples: smart sensor networks, next gen farming, aeroponic vertical farm, controlled environment agriculture]*

Support Activities for Agriculture and Forestry

NAICS code 115116 – Farm Management Services are primarily engaged on a contract or fee basis to citrus groves, orchards, or vineyards. These establishments always provide management and may arrange or contract for the operations of the farm establishment(s) they manage. Operational activities may include cultivating, harvesting, and/or other specialized agricultural support activities. *[Examples: AI-powered farm management solutions and farm management software]*

Manufacturing

NAICS code 333111 – Farm Machinery and Equipment Manufacturing companies primarily engage in manufacturing agricultural and farm machinery and equipment, such as those that plant, harvest, and mow (except lawn and garden-type*). [Examples: precision agriculture tools, digital solutions platforms, agricultural drones]*
NAICS code 333241 – Food Product Machinery Manufacturing businesses primarily make food and beverage manufacturing-type machinery and equipment, such as dairy product plant machinery and equipment (e.g., homogenizers, pasteurizers, ice cream freezers), bakery machinery and equipment (e.g., dough mixers, bake ovens, pastry rolling machines), meat and poultry processing and preparation machinery, and other commercial food products machinery (e.g., slicers, choppers, and mixers). *[Examples: food processing technology solutions, foodtech]*
NAICS code 336411 – Aircraft Manufacturing businesses primarily make or assemble complete aircraft; they may also develop and make aircraft prototypes and modify, overhaul, rebuild, and restore aircraft. *[Examples: drones, sensors and software]*

Wholesale Trade

NAICS code 423820 – Farm and Garden Machinery and Equipment Merchant Wholesalers primarily engage in the merchant wholesale distribution of specialized machinery, equipment, and related parts generally used in agricultural, farm, and lawn and garden activities. *[Examples: irrigation management data and tools, precision ag tools, ag implements]*

Information

NAICS code 511210 – Software Publishers primarily handle any operations (including virtual ones) that produce and distribute computer software. These may include designing, documenting, installing, and otherwise supporting software purchasers. These establishments may design, develop, and publish, or publish only. These establishments may publish and distribute software remotely through subscriptions and downloads. *[Examples: precision agriculture, predictive analytics, farm management software]*
NAICS code 518210 – Data Processing, Housing and Related Services primarily provide infrastructure such as web hosting, streaming services, or application hosting (except software publishing), or they may provide general time-share mainframe facilities to clients. Data processing establishments provide complete processing and specialized reports from data supplied by clients, or provide automated data processing and data entry services. *[Examples: ag data analytics and management, AI and traceability]*

Professional, Scientific, and Technical Services

NAICS code 541511 – Custom Computer Programming Services primarily engage in writing, modifying, testing, and supporting software to meet customer needs*. [Examples: predictive analytics, sensors, holistic software platform, food quality and safety, farm management software, robotics, drones]*
NAICS code 541512 - Computer Systems Design businesses primarily plan the integration of computer hardware, software, and communication technologies. They may install the system and train and support users*. [Examples: ag decision support tools, sensors, drone technology]*
NAICS code 541714 - Research and Development in Biotechnology (except Nanobiotechnology) - This industry comprises establishments primarily engaged in conducting biotechnology (except nanobiotechnology) research and experimental development. Biotechnology (except nanobiotechnology) research and experimental development involves the study of the use of microorganisms and cellular and biomolecular processes can be used to develop living or non-living materials, or change them. *[Examples: animal data (IoT technology), plant data and analysis, wastewater treatment, biological research and development]*
NAICS code 541715 - Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology) industry comprises establishments primarily engaged in conducting research and experimental development (except nanotechnology and biotechnology research and experimental development) in the physical, engineering, and life sciences. Their diverse work can involve agriculture, biology, botany, computers, electronics, environment, food, veterinary medicine, among other subjects. [*Examples: robotics and automation, food technology, agricultural research and development, novel foods and ingredients, traceability]*

AgTech Economic Evaluation

After identification of potential NAICS sectors, we compiled figures from the Mergent Intellect business database for key economic metrics as the starting point for understanding the potential of AgTech in Georgia. Because of the evolution of AgTech as a more recent and growing phenomenon, we also provide the proportion of businesses that have started within the last seven years. This measure offers some insight for potentially weighting the numbers for assessing the economic presence of the AgTech businesses within the economy.

Table 1. Annual Sales. Establishments, Jobs, and Business Age < 7 in Georgia for Potential AgTech Economic Footprint

NAICS Sector Name (% w/zero sales estimate)	**Sales ($1,000)**	**Establishments (#)**	**Jobs (#)**	**Percent < 7 yrs. in business**
Crop Production				
Other Food Crops Grown Under Cover (6.1%)	$5,868	33	404	39%
Other Miscellaneous Crops (4.5%)	$1,133,858	9,361	27,622	26%
Support Activities for Agriculture and Forestry				
Farm Management Services (6.2%)	$26,066	129	497	34%
Manufacturing				
Farm Machinery and Equipment Manufacturing (12.8%)	$9,679,612	156	4,473	19%
Food Product Machinery Manufacturing (13.9 %)	$44,709	72	1,277	13%
Aircraft Manufacturing (25.6%)	$2,330,300	129	13,152	25%
Wholesale Trade				
Farm and Garden Machinery and Equipment Merchant Wholesalers (15.6%)	$3,540,441	546	4,725	10%
Information				
Software Publishers (9.4%)	$14,905,593	1,742	21,948	19%
Data Processing, Housing and Related Services (7.7 %)	$2,515,890	1,659	16,042	17%
Professional, Scientific, and Technical Services				
Custom Computer Programming Services (6.6%)	$8,713,475	6,670	58,444	36%
Computer Systems Design (7.2%)	$7,382,650	7,124	54,980	23%
Research and Development in Biotechnology (11.1%)	$70,218	135	815	27%
Research and Development in the Physical, Engineering, and Life Sciences (9.9%)	$1,231,706	1,188	9,431	19%
TOTAL	$51,580,386	28,944	213,810	

Source: Mergent Intellect (n.d.) database, compilations, and calculations by authors.
Note: These figures are estimates from the database and are based on an unpublished methodology. Some businesses are missing these estimates as noted in the first column of the table and are not included in the total. Attempts to reach the company for details went unanswered.

Exploring Other AgTech Classifications

The NAICS-based approach has this primary advantage: its codes are used by many business data sources, including federal statistics, allowing us to make accurate comparisons across sources. Because AgTech businesses do not share a common production process (the variety and nature of the products and services), ag related products and services can't be clearly delineated. Definitions within AgTech also vary. Because a strictly NAICS-based approach presents these gaps, we reviewed other descriptions in AgTech that may support the objectives of this assessment.

Description: "AgriFoodTech" by AgFunder

AgFunder ranks itself one of the world's most active foodtech and AgTech venture capital funds (AgFunder, 2021) and coined the term "agrifoodtech" (Burwood-Taylor, 2017). Its categorization is designed to capture "broad themes" across the value chain. Integral to AgFunder's method of measuring agrifoodtech are machine learning and artificial intelligence models categorizing each funded company and its placement along the supply chain. The final step within this classification system is a manual review by a team of researchers. Since inauguration in 2017, this system has undergone some amendments to better reflect the realities of the market. The taxonomy refers to categories of businesses as *upstream* if they are closer to the farm, and *downstream* if closer to the consumer.

AgFunder offers little information about Georgia, but ranked it 16th in value of AgriFoodTech VC deals valued at $79M in 2020 (Ellis, 2021). See Figure 2 for a graphic detailing the category definitions within the agrifoodtech designation.

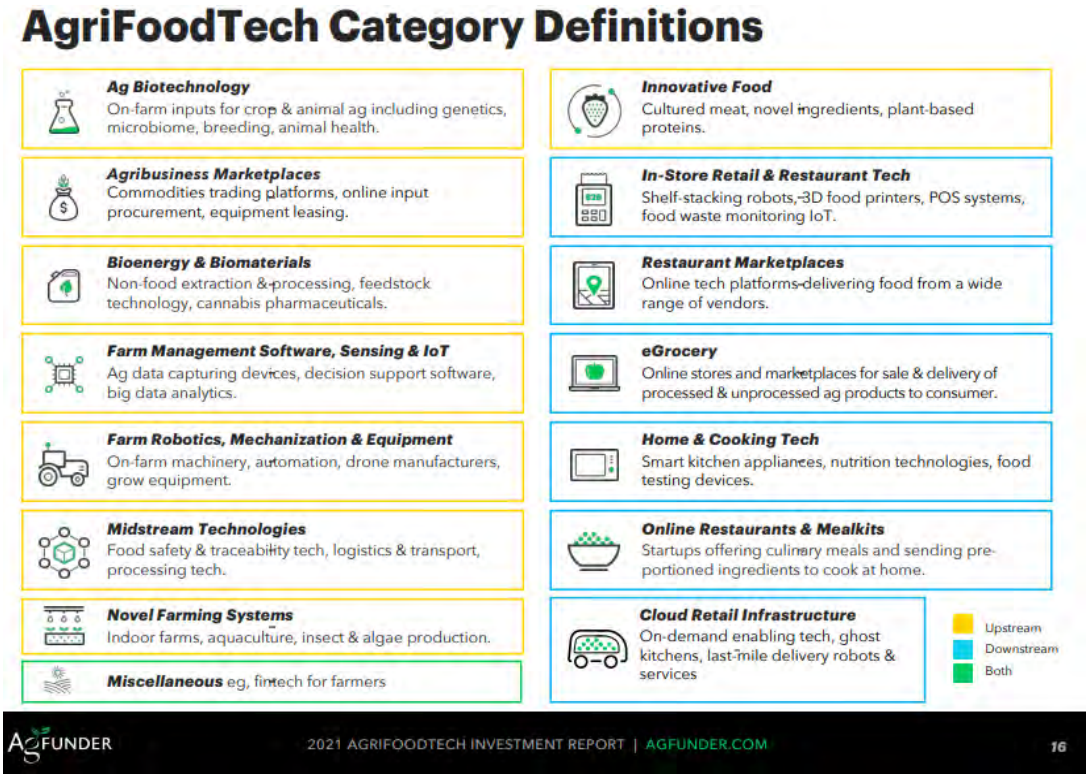

Figure 2. AgriFoodTech Category Definitions - AgFunder

Description: "Food Supply Chain Tech" by Culterra Capital

Culterra Capital focuses on advising tech-driven innovation across the food supply chain and regularly offer online Insights and industry "landscapes"—heat maps of companies comprising the layers of each segment. Because of growth and expansion, the value chain in AgTech broadened, so Culterra split their landscape into Farm Tech (inside the farm gate) and Food Supply Chain Tech (outside the farm gate) while acknowledging their interdependencies.

Farm Tech highlights these principal farmer activities:

- Digital agronomy and production encompasses much of the IoT, robotics and automation, and remote sensing activity
- Planning and farm management covers digital agronomy, resource management, and business planning and execution
- Market access and financing are tools and technologies used by farmers, farm managers, and crop buyers to access markets and financing. (Day, 2020)

Food Supply Chain Tech affects the value chain between the farm and grocery or food service provider. It has a clear IT focus, and its four primary areas include:

- First mile (supply): the harvest forecasting, logistics, producer/order management, monitoring, quality, and safety control, B2B procurement, as well as trade analytics technologies
- Production/food processing: consumer packaged goods product innovation, enterprise resource planning, manufacturing automation and robotics, and manufacturing operations management technologies
- Distribution and logistics: the supply chain analytics, cold chain logistics, third-party logistics, warehouse automation, vendor/order management, logistics marketplaces, and transportation management and visibility technologies
- Retail/food service/D2C (demand): food and beverage demand data analytics, demand planning and management, omnichannel/direct to consumer (D2C) logistics, B2B procurement, and food recovery technologies. (Day and Rosenheim, 2020)

Culterra's landscape graphics (See Figure 3) result from its analysts tracking several thousand companies whose logos fill each market map. Typical filters include companies that are venture funded, have demonstrated market traction via measures such as customers, acreage, pilots, press releases, channel partnership mostly from developed (vs. developing) countries, and applied technology focus (Day, 2021). Culterra's approach does not use a classification system or include metrics for organizations depicted.

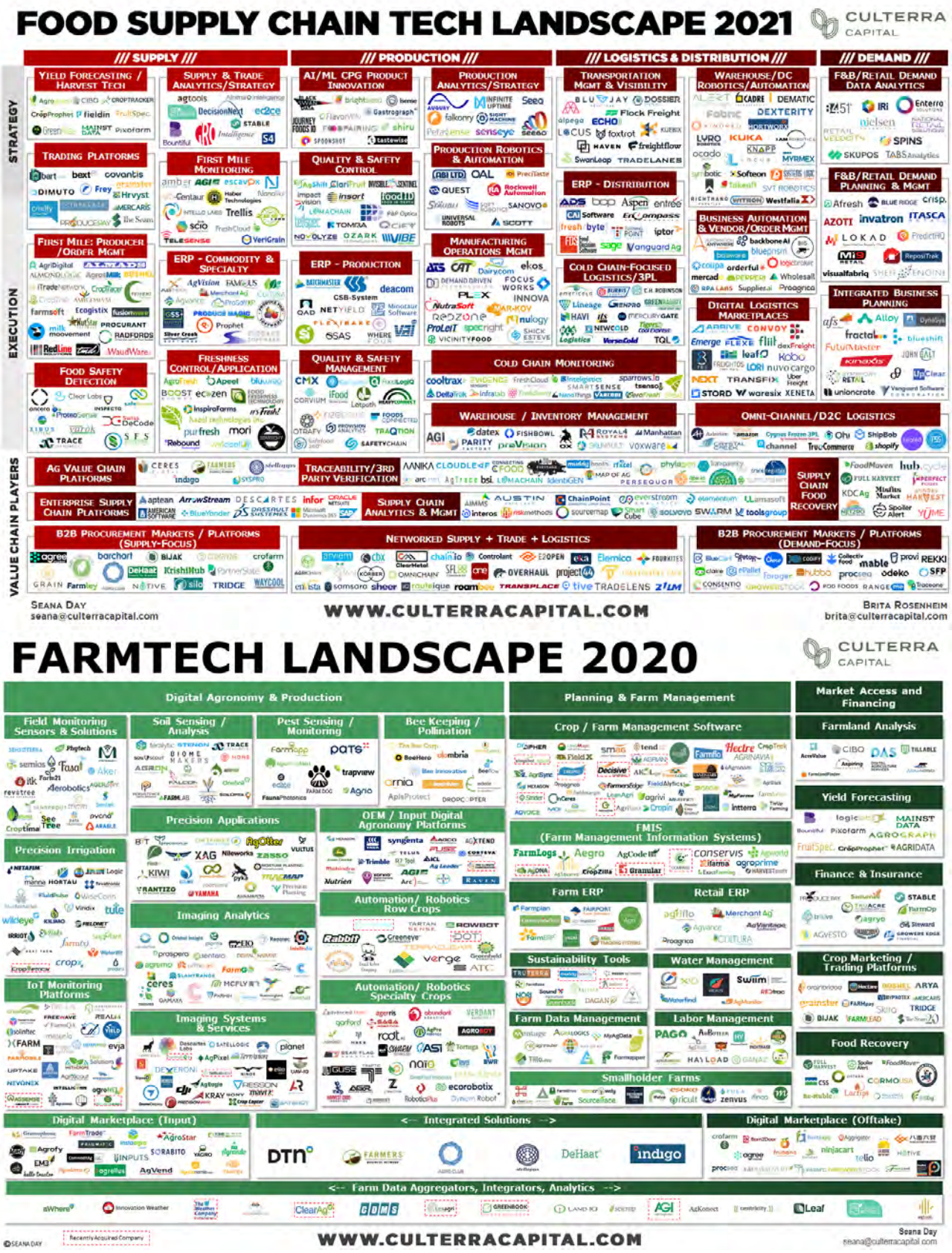

Figure 3. Culterra Capital AgTech and FarmTech Landscapes

Description: "AgTech" by Juniper Research

According to Juniper Research, AgTech encompasses agricultural management platforms, supply chain and inventory management solutions, GPS services and field mapping services, agricultural monitoring services, and micro-farming solutions. In 2021, the worldwide market value of these sectors combined stood at $10.5 billion, led by the North American market at $6.2 billion.[8] (See Figure 4). Beyond describing specialization in "*identifying and appraising high growth market sectors within the digital ecosystem*," Juniper does not offer specific definitions of its AgTech sector, and Georgia-specific data is unavailable. Juniper estimates a worldwide $22.5 billion AgTech market value in 2025, with 67 percent from agricultural monitoring sensors and supply chain management.

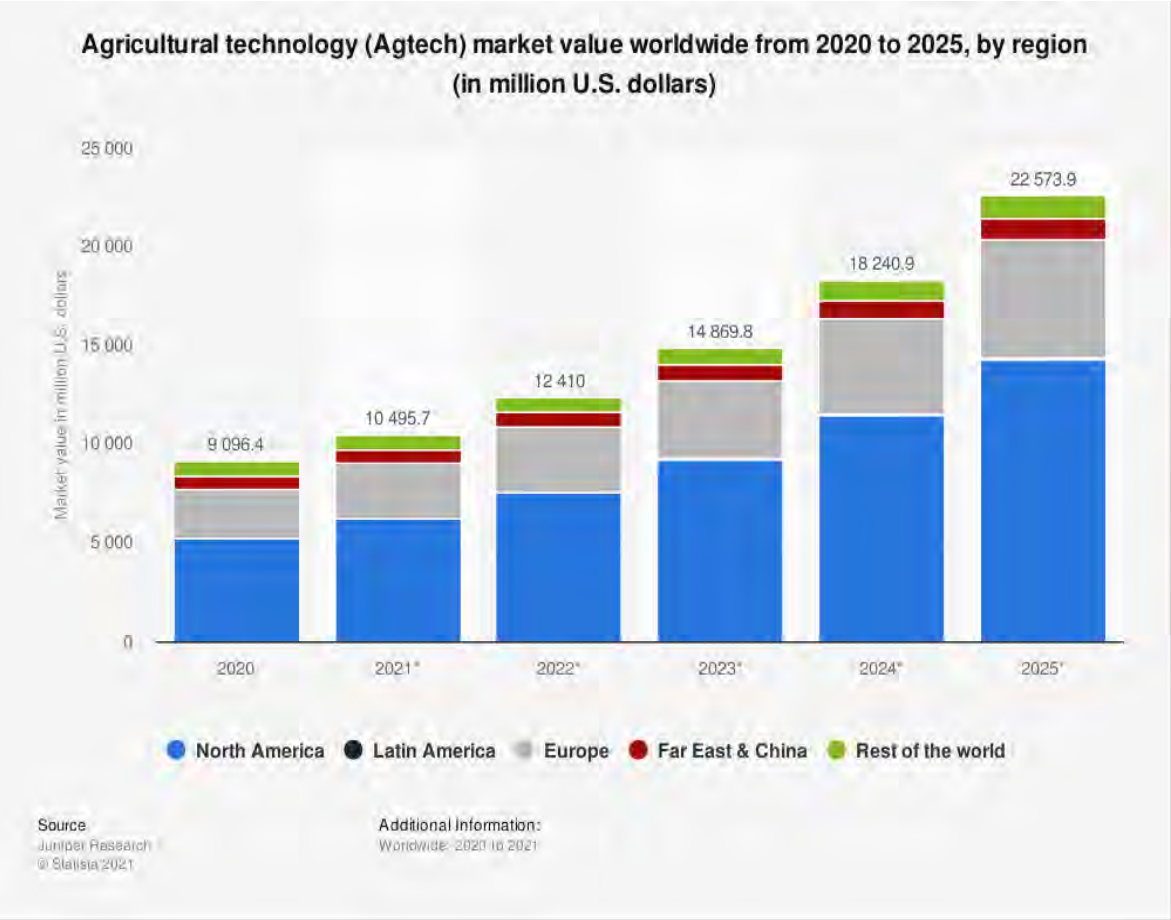

Figure 4. AgTech market value worldwide from 2020 to 2025 by region

[8] https://www.statista.com/statistics/1222535/worldwide-agricultural-technology-market-value-by-region/

Description: "THRIVE Top 50" by SVG Ventures

Based in Silicon Valley, THRIVE is a "global AgriFood innovation platform" that includes top agriculture and foodtech corporations, universities and investors. THRIVE (thriveagrifood.com) seeks to "solve the biggest challenges facing the food and agriculture industries." It partnered with Forbes to list the Top 50 AgTech and foodtech companies, put together by researchers and corporate partners. Most relevant to CAED's study is not the top companies, but the criteria for each analysis.

These criteria include the funding stage (Series A and beyond), sector (placement in the value chain), proven technology with product in market, demonstrated traction at scale, and established founding team with a track record. All listed AgTech companies must be B2B. Applying icons for visualization, SVG's categorization scheme includes technology category, problem addressed, and value chain position, with AgTech adding the farming type (SVG Ventures 2020).

Table 2. SVG Ventures - THRIVE Top 50 AgTech and FoodTech Criteria

AGTECH	FOODTECH
Technology Category	
Biotechnology Controlled Environment Ag Data Analytics & AI IoT Software & Hardware Robotics & Automation	Biotechnology Data Analytics & AI Foodtech IoT Software & Hardware Packaging Tech Robotics & Automation Other
Problem Area Addressed	
Animal Health & Nutrition Crop Nutrition, Health & Protection Environmental Impact & Waste Farm Management & Forecasting Food Safety Labor Traceability Water	Environmental Impact & Waste Food Quality & Safety Novel Foods & Ingredients Processing Storage, Transportation & Distribution Traceability Trade
Value Chain Position	
Complete Farm Cycle Harvesting In Season Livestock Management Plant Breeding & Pre-Planting	CPG & Retail Food Processing Post-Harvest Waste & Other
Farming Type	
All Crops Commodity Crops Dairy Livestock Permanent Crops Specialty Crops	N/A

Description: "Venture Capital (VC) Categorization Method" by Graff et al.

In a study exploring factors influencing increased investment in agricultural technology startups, the authors construct a unique global dataset for which the descriptive information was quite heterogeneous. The method analyzed the business information or activity fields for each startup, querying for specific words or descriptions. This represents a valid framework for consistently reviewing businesses for categorization, but we note that no apparent official classification system is utilized nor is the precise information known for each business. We include Table 3 as possibly relevant because of the keywords searched.

Table 3. Venture Capital Categorization Method

Category	Business Type/Keyword
Software/Data	software
	app
	data
	analytics
	artificial intelligence
	machine learning
	blockchain
	distributed ledger
Devices/Sensors	any mention of device, sensor, smart or automated systems, measurement or monitoring in electronics context
	hardware (as opposed to "software")
	lighting or LED systems for contained or indoor agriculture
	control systems
	robots, drones, unmanned or autonomous vehicles (UAVs)
	Note: technologies/products that would be in "electrical engineering," not machinery or equipment that would be considered "mechanical" "civil" or "hydrological" engineering (these are under MACHINERY, EQUIPMENT category)
Biotech/Genetics/Health	companies described as biotech
	companies that mention genetics
	breeding
	biological control
	biopesticides
	biofertilizers, compost, biochar, other biological soil amendments
	microbial/microbiome
	animal health, including vaccines but not feed additives
	animal reproduction, such as sexing, artificial insemination
Chemicals	agrochemical manufacturing
	agchemical manufacturing
	"-icides" that are not related to biotech
	nanomaterials
	Mention of a specific class of chemical compounds that characterize products
	Inert materials with beneficial properties as soil additives, fillers, growth media, polymers, etc.
	NOTE: use of this category indicates R&D or manufacturing, not merely distribution or "provider" of chemical products
Equipment or farm machinery	manufacture of farm machinery or equipment
	develop or sales of vertical or indoor ag equipment and infrastructure that is not included in electronic devices sensors systems

Category	Business Type/Keyword
	Note: not distribution, import, or sales of farm machinery and equipment, these are under AG INPUTS DISTRIBUTION SALES category
Ag Input Distributors / Dealers / Co-ops	Distribution, sales, retail, wholesale, supply, provision of ag inputs including: seeds, plant starts; ag chemicals, pesticides, fertilizers; biological amendments, biological inputs; animal feed, feed additives and supplements; animal health, veterinary products, and supplies; young live animals (e.g. chicks, fish fry, etc.); farm supplies; aquaculture supplies; machinery and equipment (for farm, ranch, aquaculture, fishing, timber operations); parts and services
	small minority include "agricultural services" such as contract harvesting, piecework, agronomic consulting services, monitoring, management
	does not include provision of or contracting ag labor, human resource services were all under BUSINESS AND FINANCIAL SERVICES category
	if feed, often in combination with PROCESSING category, if company also manufactures or produces the feed, which is often grain or oilseed milling
Ag Producers or Farms	actual operation of a farm or other production operation
	cultivation
	production
	provision of agricultural services
	name of commodity produced
	in combination with MARKETING PROCESSING category if vertically integrated business, such as livestock, oil palm
	in combination with MARKETING PROCESSING category if fresh market, such as fruit, vegetable, produce
	in combination with MARKETING PROCESSING category and with CONSUMER category if "community supported agriculture (CSA)," "farm to table," "locally produced," etc.
Marketing, Processing, Manufacturing	post-harvest marketing, distribution, export/import, brokering
	transportation, logistics
	processing, milling
	animal slaughter, meat processing, meat packing
	grain milling
	feed milling
	oil pressing, processing
	cotton ginning
	saw mills
	ethanol plants
	other fermentation, extraction, separation, purification by ingredient manufacturing; animal feed additives (often amino acids, micronutrients, etc.)
	food manufacturing; food brand or category for broad market (i.e. national or commodity-wide); wineries; breweries; distilleries
Consumer Products or Services	consumer, home, household
	retail-specific product name
	marketing or distribution to the final consumer (not to stores, restaurants, food service, etc.)
	consumer connected to production/distribution, e.g. community agriculture, farm-to-table
	garden, gardening supplies, garden equipment, indoor gardening systems for home (not for horticulture or greenhouse industry)
Business and Financial Services	real estate
	land brokerages
	human resource management, labor contracting, training, education services
	financial services, investment
	insurance, risk management

Category	Business Type/Keyword
	industry associations and advocacy
	economic development and regional development organizations
	B2B services or marketplaces, in combination with ONLINE category
	publishing, catalogs, information for industry clients, may be in combo with ONLINE category
	consulting, advisory services
	contract research services
Online Services and Content	online, website, web, portal, platform
	B2B, B2C", but almost always in combination with another appropriate industry category
	apps or mobile often in combination with SOFTWARE, DATA, and IT category

Recommended Ongoing Research

Our nascent industry metrics of the AgTech sector in Georgia are rooted in NAICS classifications which relate to businesses and activities in the value chain from the farm to the end-user, from which AgTech products, services, and innovations occur. NAICS codes paired with existing information sources offer a broad-brush view of AgTech potential through existing economic data, annual output (sales or revenue), and numbers of establishments and jobs. The NAICS-based production-oriented system does not perfectly reflect AgTech today; it's very design misses products and processes being developed by ag-related businesses. Closing these gaps, and producing a comprehensive view, requires other methods of assessing the AgTech sector.

Robust industry metrics will surface, and Georgia can be part of that leading edge by building on this study. We recommend combining assessment methods that fit COI priorities in Georgia.

1. Formally decide which definition (or combination of definitions) applies best, while understanding that these are fluid as more information becomes available. Plan for dynamically reviewing and revising as the sector evolves. A formal decision creates reasonable segregation points for documentation (such as the AgFunder definitions of Upstream and Downstream, or Culterra Capital/THRIVE Top 50 delineations between "up to farm gate" and "past the farm gate.")
2. Use the formal definition(s) to delve into NAICS-based data for further detail about each grouping and available information sources. This investigation will help to isolate the NAICS sectors belonging to AgTech activities, products, and processes. Monitor the identified firms for key economic metrics.
3. Consider an in-depth search of individual firm documentation using keywords from the Venture Capital Categorization method, which enables COI to verify activities and markets of each firm. The result of this investigation would be to isolate the portion of the NAICS sector belonging to AgTech activities, products, and processes.
4. Follow regular venture capital publications and reports for emerging technology applications and innovations; incorporate (and document) these ongoing findings into the formal definitions.
5. Supplement AgTech quantitative efforts with case studies of Georgia enterprises. These narratives might track, in detail, the success of an incumbent in the sector or the innovative mindset of a new entrant regarding their product or service.

A Final Word

The accelerating nature of AgTech makes this CAED report a necessarily brief snapshot in time. The exciting pace of AgTech and its promise for Georgia's economy can, at this moment, only be measured with existing tools, and these lack the precision that we would like to provide COI. The scale of AgTech, with so much investment and returns already at stake, strongly suggests that better measurements are rapidly developing.

As existing metrics become more refined and newer ones surface, and data collection methods offer more targeted results, CAED looks to continue its partnership with COI to pinpoint the AgTech areas of greatest promise for our state. Georgia has so much to gain now and in the near future, as well as for the long term, through its relationship with AgTech and our shared expertise. We are only seeing today some of what AgTech promises, and in the expectation of this first imperfect glimpse rapidly becoming clearer, CAED looks forward to building on this foundational work.

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The Center for Agribusiness and Economic Development

The Center for Agribusiness and Economic Development is a unit of the College of Agricultural and Environmental Sciences of the University of Georgia, combining the missions of research and extension. The Center has among its objectives:

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>
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