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Zacks Small-Cap Research

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Brian Marckx, CFA
312-265-9474
bmarckx@zacks.com

scr.zacks.com
10 S. Riverside Plaza, Chicago, IL 60606

Arcadia Biosciences, Inc. (RKDA-NASDAQ)

Initiating Coverage: ***Leveraging Gene-Editing Expertise to Target High Growth Markets. Anticipating 3 Key Launches, Steepening Growth Curve***

DCF values RKDA ~$12/share on fully diluted basis (share count inc. registered direct offering of 1.3M shares announced today (9/6), expect close by 9/10). Our $12/share DCF-derived PT implies P/S-2021 of ~8x (discounted to present at 10%/yr) – which, given anticipated steep growth rate, is reasonable (arguably, conservative) in our opinion

Current Price (09/06/19)	$6.54
Valuation	**$12.00**

OUTLOOK

Arcadia's expertise and technologies allow for rapid development and commercialization of novel traits. These advanced gene-editing and breeding capabilities provide them with significant advantages in our opinion, as the ever-increasing competitive landscape among consumer food and health companies has placed greater importance on time-to-market and the ability to successfully and reliably develop healthy food options and value-added product differentiation.

Arcadia quickly built a foundation for growth by scoring key product regulatory approvals and securing talent, resources and expertise via recent consummation of collaborations/partnerships. This includes a JV and collaboration related to their hemp/CBD and non-GM wheat programs, respectively, both of which were announced in August. Revenue from both is expected to begin this year and quickly steepen in 2020. RKDA's drought tolerant soybeans, a third catalyst, is expected to make its commercial introduction next year in Argentina.

Having laid the groundwork for growth and on the cusp of three key product launches, RKDA recently issued initial financial guidance of; revenue in excess of $10M and $30M in 2020 and 2021, respectively, and reaching a point of positive cash flow from operations by mid-to-late 2021. We are initiating coverage of RKDA with a $12/share target price.

SUMMARY DATA

52-Week High	**$10.40**
52-Week Low	**$1.82**
One-Year Return (%)	**32.86**
Beta	**-4.01**
Average Daily Volume (sh)	**3,026,540**
Shares Outstanding (mil)	**8**
Market Capitalization ($mil)	**$50**
Short Interest Ratio (days)	**N/A**
Institutional Ownership (%)	**6**
Insider Ownership (%)	**33**
Annual Cash Dividend	**$0.00**
Dividend Yield (%)	**0.00**
5-Yr. Historical Growth Rates	
Sales (%)	**-30.2**
Earnings Per Share (%)	**N/A**
Dividend (%)	**N/A**
P/E using TTM EPS	**N/A**
P/E using 2019 Estimate	**N/A**
P/E using 2020 Estimate	**N/A**
Zacks Rank	**N/A**

Risk Level	**High,**
Type of Stock	**Small-Growth**
Industry	**Agriculture/Pro**

ZACKS ESTIMATES

Revenue
(in millions of $)

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2017	1.0 A	1.0 A	0.6 A	1.4 A	4.0 A
2018	0.2 A	0.4 A	0.4 A	0.4 A	1.5 A
2019	0.2 A	0.2 A	0.3 E	0.5 E	1.1 E
2020					6.3 E

EPS

	Q1 (Mar)	Q2 (Jun)	Q3 (Sep)	Q4 (Dec)	Year (Dec)
2017	-$1.90 A	-$1.88 A	-$2.12 A	-$1.38 A	-$7.28 A
2018	-$4.86 A	-$2.02 A	$0.93 A	-$0.13 A	-$3.58 A
2019	-$2.64 A	$0.84 A	-$0.82 E	-$0.68 E	-$3.15 E
2020					-$2.54 E

Zacks Projected EPS Growth Rate - Next 5 Years % **N/A**

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SNAPSHOT

Arcadia Biosciences, Inc (RKDA) is an innovative agricultural company with a broad and growing product portfolio focused largely on improving the nutritional and other valued-added qualities of crops and consumer food products. The company owns or exclusively licenses 216 patents worldwide across 30 patent families. Through leveraging of their TILLING (Targeting Induced Local Lesions in Genomes) and in-licensed CRISPR Cas-9 platforms, RKDA has created a niche position as a developer of high value non-genetically modified (non-GM) traits, the market for which is experiencing significant and broad-based growth as consumer demand continues to shift more towards natural food options. Arcadia's large patent estate provides them with the ability to gain full control over crop genome advancements, thereby affording the relatively unique advantage of obtaining patents on non-GM traits.

These technologies also allow for relatively rapid development and commercialization of novel traits, which in some instances can be accomplished in approximately one-half of the time as more traditional techniques. These advanced gene-editing and breeding capabilities provide Arcadia with significant advantages in our opinion, as the ever-increasing competitive landscape among consumer food and health companies has placed greater importance on time-to-market and the ability to successfully and reliably develop healthy food options and value-added product differentiation.

Arcadia's technological innovation brought **SONOVA GLA safflower** to market. SONOVA GLA, developed under a licensing agreement with Abbott Laboratories (ABT), contains the highest concentration of gamma linolenic acid (GLA) of any other currently available plant oil. GLA has important health and anti-aging benefit and is used in a variety of products including dietary and nutritional supplements, medical foods and, more recently, dog and cat foods. While SONOVA GLA is Arcadia's sole commercial product, other, higher-potential programs (i.e. non-GM wheat, hemp/CBD and drought-tolerant soybeans) are where most of the company's growth opportunity lies. These also represent the bulk of the equity investment value of RKDA, in our opinion.

Arcadia has rapidly built a foundation for growth by scoring key product regulatory approvals and securing talent, resources and expertise through the recent consummation of collaborations and partnerships with industry-leading organizations. This includes a joint-venture and collaboration related to their hemp/CBD and non-GM wheat programs, respectively, both of which were announced in August. Revenue from both programs is expected to begin later this year and quickly steepen going into 2020. Meanwhile, proprietary drought tolerant soybeans, which represents a third catalyst, is expected to make its commercial introduction next year in Argentina.

Having laid the groundwork for growth and on the cusp of three key product launches, in late-August the company issued initial financial guidance. This includes expectations of **generating revenue in excess of $10M and $30M in 2020 and 2021, respectively, and reaching a point of positive cash flow from operations by mid-to-late 2021**.

One of the company's flagship pipeline programs is their **GoodWheat brand**, representing proprietary non-GM varieties of wheat with improved nutritional value, including one wheat that contains very high levels of amylose. This is a significant value-added trait as it conveys high dietary fiber content, a characteristic that has become increasingly important among both consumers and food companies. Arcadia's GoodWheat product line currently consists of High Fiber Resistant Starch, Extended Shelf Life and Reduced Gluten wheat varieties.

In March 2018 the company announced that, through their advanced development technologies, they were able to achieve up to 94% amylose (corresponding to high levels of resistant starch) in their Resistant Starch wheat program, which is the highest levels available. Concurrently, Arcadia reported that their GoodWheat varieties deliver levels of dietary fiber that meet the U.S. Food and Drug Administration (FDA) threshold for claiming a "Good Source" of fiber or "High in Fiber" on consumer packaging. GoodWheat's addressable U.S. market is estimated to be as much as $9.7B.

A collaboration between Arcadia, Arista Cereal Technologies and Bay State Milling, signed in late-August, is a key milestone towards commercializing their high fiber resistant starch wheat in North America, Europe and portions of Asia (the agreement also eliminates what had been an ongoing patent dispute between Arcadia and Arista). Meanwhile, a collaboration with Ardent Mills, a leading North American flour-milling and ingredient company, is focused on furthering development of their Extended Shelf Life program. The company also has other wheat-related projects ongoing, including a strategic collaboration (entered in August 2017) with Corteva Agriscience (CTVA), the recently spun-off agricultural unit of DowDuPont (DWDP), which is leveraging each companies' technologies for the development and commercialization of "a breakthrough improved wheat quality trait" in North America.

Meanwhile, **Verdecca LLC**, a joint-venture between Arcadia and Bioceres, a major Argentinian crop and seed trait agri-bio company, is focused on the development of (GM) **drought tolerant soybeans**, the annual commercial market for which is estimated to be worth ~$25B. Brazilian and USDA regulatory approval of their HB4 drought tolerant soybeans, critical commercialization-related gating factors, were achieved in May and August 2019 (which follows FDA approval, received in August 2017), respectively. The HB4 trait now has regulatory approvals covering more than 80% of the global soybean market. Assuming successfully gaining import approval from China (by far the largest importer of soybeans), Arcadia anticipates the initial launch of their HB4 soybeans (grown in Argentina) happening in early 2020.

Arcadia Specialty Genomics (ASG) is one of the company's most recent ventures. Formed in February 2019 and seeking to leverage the burgeoning U.S. interest in hemp-based products, ASG is a new business unit focused on the development and commercialization of genetic improvements related to the plants content, quality, climate resiliency and yield. ASG's development strategy, which heeds U.S. state and federal laws and regulations, will initially focus **on hemp (i.e. a non-psychoactive strain of the cannabis plant) and hemp-derived products**. Arcadia commenced its initial hemp-related research program earlier this year through an Industrial Hemp Pilot Program in Hawaii **and in August announced the formation of Archipelago Ventures**, a joint-venture with Legacy Ventures Hawaii, to grow, extract and sell superior sun-grown hemp.

Leveraging ASG's genetic expertise and licensed Hawaiian cultivation facility and Legacy's proven extraction and sales capabilities, Archipelago Ventures represents a complete seed-to-sale supply chain for hemp-derived cannabidiol (CBD) products. In addition, Archipelago will have access to Legacy's equity partner, Vapen CBD, a division of publicly traded Vapen MJ Ventures (OTC: VAPNF), which will build and operate Archipelago's Hawaiian hemp extraction facilities. With their first hemp harvest completed and expectations that Archipelago's extraction facilities are operational in the coming months, Arcadia anticipates that CBD oil sales could commence by current year-end (contingent on regulatory authorization) and ramp quickly thereafter.

Arcadia looks to exploit accelerating demand in rapidly growing markets…
The markets for Arcadia's products are expanding as the company looks to leverage the growing demand for healthier, non-GM foods and the rapidly burgeoning interest in CBD which has been spurred, in part, by recent passage of the U.S. 'Farm Bill' As the average American's daily diet currently includes approximately 500 calories worth of wheat products (equal to ~25% of the FDA's total recommended caloric intake) and consumers are placing evermore importance on 'gluten-free' and fiber-rich foods, the market for GoodWheat is large and rapidly expanding. And in addition to consumer preferences, non-GM foods have other inherent advantages over their genetically modified counterparts, including less costly and time-consuming regulatory oversight in the U.S. and access to markets where GMO foods have been banned, such as Europe and Asia.

Interest in and demand for CBD has exploded since passage of the U.S. Agriculture Improvement Act of 2018 (i.e. the 'Farm Bill'), which went into effect on January 1, 2019 and completely removed hemp from regulation under the Controlled Substance Act. Research on and use of CBD for a variety of health-related applications has blossomed and facilitated demand that industry-watchers estimate will generate revenue of up to $22B annually by the year 2022. Consumer spending on CBD products, including edibles and vapes products, and increasing use of it in medical applications are expected to be the main drivers of global demand, approximately 50% of which is from the U.S.

Arcadia's yield and stress-related pipeline (most notably their HB4 drought tolerant soybeans) also target rapidly emerging markets. While crop trait development has historically focused on herbicidal and insecticidal traits, abiotic factors, such as drought and soil salinity, have proven to be much more problematic to crops. The relative dearth of competing drought tolerant soybean traits means this is a market for the taking.

We are initiating coverage of RKDA with a $12/share price target.

BACKGROUND

Much of Arcadia's history was dedicated to the development of abiotic stress traits with a focus on enhancing the robustness of crops and on improving yields and aimed largely at growers. While the company had some success in that regard, the shift in regulatory and consumer attitudes away from GM foods provided an opportunity for Arcadia to leverage their technologies and industry relationships towards the non-GM space and a more dedicated focus on consumer food companies.

This recent shift in strategy was facilitated by the adoption of additional technology, which was bolstered in 2017 with the in-licensing (from MIT and Harvard University) of CRISPR-Cas9 gene-editing technology. CRISPR-Cas9 complements Arcadia's TILLING platform, the combination of which is expected to significantly reduce the time that it takes to bring discoveries to market. TILLING functions as a way to create seed and DNA libraries by identifying certain attractive mutations in specific genes while CRISPR-Cas9 allows for direct gene-editing of a crop's DNA with the goal of enhancing attractive traits. The combination of TILLING and CRISPR-Cas9 is estimated to reduce time-to-market of a novel discovery by approximately two years versus TILLING alone (i.e. three to five years total versus five to seven years).

Snapshot of the Agribusiness Food Chain

Sector	Input	Farmers	Traders	Food companies	Retailers
Sales: US$bn (*approx.*)	400	3,000	1,000	3,500	5,400
Number of players	100s	450 million	Tens	Thousands	Millions
EBIT %	15%	Variable	2–5%	10–20%	5%
R&D % sales	<1% (fertilizers) – 10% (seeds)	0%	<1%	1–2%	<1%
R&D spend: US$bn	10	–	Low	8	Low
Composition/ Sub-sectors	• Seed • Fertilizer • Crop protection • Machinery • Animal health and nutrition • Crop insurance • Food ingredients	• Grains • Fruit and vegetables • Meat • Dairy	• Handling • Primary processing • Secondary processing	• Bakery • Meat • Dairy • Snacks • Ready meals • Beverages	• Multiples • Discounters • Wholesalers • Independents
Range	R&D-based majors to generic manufacturers	Smallholders to agroholdings	Global agribusinesses to local middlemen	SMEs to multinationals	Corner shops to hypermarkets

Source: KPMG. The agricultural and food value chain

As the company notes in their recent SEC filings, their commercial strategy is now on migrating "forward in the ag-food supply chain from the farmer and seed company to the consumer food company." While, historically, licensing and contract research and government grants had accounted for a majority of revenue, Arcadia's recent transformation into a consumer products and ingredients company means that an increasing amount of future sales should come from food and other products that incorporate their proprietary traits.

Arcadia's Pipeline -

GoodWheat

Arcadia is developing GoodWheat to meet the growing needs of consumers as it relates to natural (i.e. non-GM) and healthier food options. Growth in demand of this segment is evidenced by recent industry surveys that found that, among other things; a) nearly three out of four consumers would be willing to pay higher prices for foods made with ingredients that they recognize and b) more than nine out of ten U.S. consumers believe that food made with recognizable ingredients is healthier. Despite this growing demand, wheat has witnessed little in the way of innovation. Arcadia is looking to capitalize on this disconnect with GoodWheat.

Their GoodWheat brand consists of proprietary varieties of wheat that contain value-added nutritional attributes, such as very high levels of amylose. This variety conveys high dietary fiber content, a characteristic that has become increasingly important among both consumers and food companies. Arcadia's GoodWheat product line currently consists of High Fiber Resistant Starch, Extended Shelf Life and Reduced Gluten wheat varieties. Combined, these addressable markets are estimated to be worth about $9.7B per year. GoodWheat can be delivered as either organic or conventional wheat.

In March 2018 the company announced that, through their advanced development technologies, they were able to achieve up to 94% amylose (corresponding to high levels of resistant starch) in their Resistant Starch wheat program, which is the highest levels available. Concurrently, Arcadia reported that their GoodWheat varieties

deliver levels of dietary fiber that meet the U.S. Food and Drug Administration (FDA) threshold for claiming a "Good Source" of fiber or "High in Fiber" on consumer packaging.

The counter-season GoodWheat production trials were completed earlier this year and subsequently harvested with higher than anticipated yields. Harvest of their Spring wheat, which was planted in Q2, is expected to happen in the current (i.e. Q3'19) quarter. The recent harvests showing improving performance and higher yields led up to a collaboration between Arcadia, Arista Cereal Technologies and Bay State Milling Company. Signed in late-August, this represents a key milestone towards commercialization of the company's high fiber resistant starch wheat in North America, Europe and portions of Asia.

Bay State Milling, founded in 1899, brings milling and supply chain identity preservation. Bay State's 'core purpose' is to "provide food ingredients to promote the growth of healthful and affordable food choices for the consumer" and has a 'strategic intent' to "support the growth of the next generation of grain-based foods in North America by providing the leading array of plant-based ingredients".

Arista Cereal Technologies is a joint venture formed in 2006 between "Limagrain, a fifty-year-old farmer-founded and directed, world player in wheat seeds, and CSIRO, a globally recognized organization focused on using science to make a positive difference in the world for nearly one hundred years." Arista was created to "develop a wheat with direct consumer health benefits."

Per the collaboration agreement, Bay State will be Arcadia's exclusive partner for their high fiber wheat in North America under Bay State's *HealthSense* brand while Arista has exclusive rights to Arcadia's intellectual property in Australia, New Zealand, Europe, Japan and S. Korea. Arcadia retains full commercialization rights to their GoodWheat portfolio in all other markets. In addition to providing the infrastructure and related capabilities for commercialization of the company's high fiber resistant starch wheat technology, the agreement also eliminates what had been an ongoing patent dispute between Arista and Arcadia.

Arcadia anticipates commercialization and related revenue of their high fiber wheat to commence this year and expects sales to quickly accelerate beginning in 2020. Meanwhile, development progress of the Extended Shelf Life program should benefit from a collaboration with Ardent Mills (announced in late-2018), a leading North American flour-milling and ingredient company.

- High Fiber Resistant Starch

  Resistant starch is naturally found in many foods high in carbohydrates such as potatoes beans and grains. Resistant starch 'resists' digestion by the body in such a way that it has been proven to have a positive effect on weight loss and overall health. Resistant starch has been shown to reduce hunger but to also facilitate the body's ability to burn calories and eliminate fat.

  Increasing rates of obesity, heart disease and awareness of the benefits of high fiber diets is helping to propel growth in demand for fiber-rich foods and in particular, resistant starch products. Mordor Intelligence estimates that the global food fiber market will expand at a 9% CAGR over the next five years and be worth nearly $88B by the year 2024.

  Arcadia's Resistant Starch wheat is unique in that it is non-GM, non-chemically altered and has high levels of resistant starch. Their Resistant Starch wheat has resistant starch levels that are 12 to 20 times higher than conventional wheat, which translates to total dietary fiber eight times higher than that of conventional wheat. This provides food manufacturers with a wheat option that can intrinsically increase the total dietary fiber content of their food products without the need for fiber additives.

  Results of initial testing of Arcadia's Resistant Starch wheat in food products was positive. This included loaf quality made from Resistant Starch wheat which was rated to be comparable to that of bread made with conventional wheat and pasta which returned the highest consumer rankings from testing completed by a major consumer products company. Arcadia's Resistant Starch wheat is expected to represent one of the first of its products to market and is about to undergo additional testing in a variety of products including bread, pasta and animal feed.

- Reduced Gluten

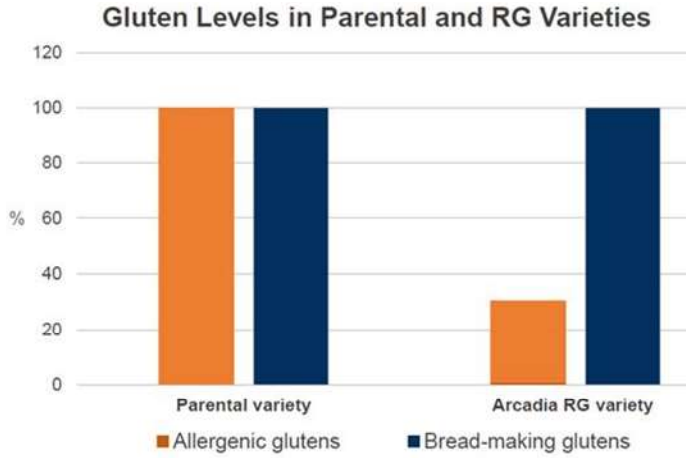
  Gluten is a generic description of certain proteins found in wheat (as well as other grains such as rye and barley) that, when processed into foods, acts as a glue and helps the products maintain their shapes. Foods that commonly contain wheat (and therefore wheat gluten) include bread, pasta, pastries, cereal and certain sauces (among a host of others). Gluten sensitivity, which is increasingly common (the 'increased prevalence' of which is likely mostly due to greater awareness and diagnosis of the condition), refers to the body's immune reaction (i.e.

inflammation of the GI system) following ingestion of foods containing gluten. Symptoms can include general digestive discomfort, diarrhea, constipation and damage to lining of the digestive system.

While celiac disease refers to a serious autoimmune disorder characterized by a genetic allergic predisposition to gluten, intolerance to this protein is not confined to only people with this condition. Approximately 3M Americans suffer from celiac disease while another ~20M people in the U.S. are estimated to have non-celiac gluten sensitivity. While the only truly effective treatment for gluten sensitivity is eliminating the offending protein from the diet, consistently and effectively doing so has often been found to be excruciatingly difficult.

This difficulty can be for a variety of reasons, including identifying problematic foods, difficulty adhering to extended trial-and-error food elimination diets and maintaining relatively bland menus. As such, successful development of a reduced gluten, 'acceptable' tasting wheat would almost certainly generate massive interest from much of the ~23M Americans (and ~7% of the global population) with gluten sensitivity. This is in addition to a portion of the non-gluten sensitive population (the research firm The Connell Group found that approximately 26% of the non-celiac disease population is interested in reducing gluten from their diets). Grand View Research estimates the global gluten-free products market is currently worth ~$18B and projects it to grow at a CAGR of over 9% and reach $32B by 2025.

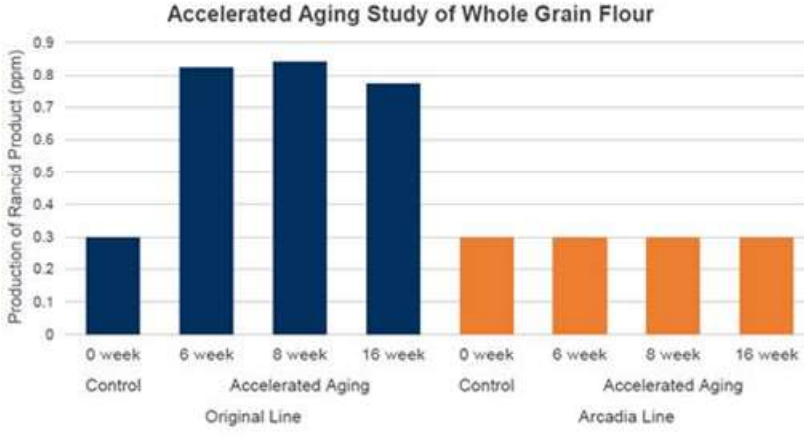
Arcadia's Reduced Gluten wheat contains up to 70% fewer allergenic glutens and more essential amino acids (such as lysine) than traditional wheat.



Source: Arcadia Bio

- Improved Shelf Life Wheat

Arcadia is also developing traits to extend the shelf life of wheat. This product aims to reduce the rancid and bitter compounds in aged whole grain flour, which are byproducts of milling and often cited as reasons why consumers do not eat more wheat products. Arcadias improved shelf life wheat, which oxidizes more slowly when milled, provides for meaningfully less rancid and bitter compounds in aged whole grain flour. In October 2015 the U.S. Patent and Trademark Office granted Arcadia a patent for extended shelf life wheat.



Source: Arcadia Bio

- Ardent Mills Collaboration: Extended Shelf Life Wheat

Less than a month after Arcadia announced that the USPTO granted them a patent for extended shelf life wheat, the company announced (in November 2018) that they entered into a collaboration with Ardent Mills, LCC, "North America's leading flour-milling and ingredient company." The duo with focus on the development and commercialization of innovative wheat varieties with their initial efforts going towards extending shelf life and improving the flavor of whole wheat products. Ardent Mills brings extensive capabilities, resources and industry contacts and relationships. Their leading position in U.S. flour-milling means Arcadia has a seamless and direct route to market.

Arcadia Specialty Genomics: *Hemp traits*

Created in February 2019, ASG is focused on the development and commercialization of genetic improvements of hemp. Arcadia will leverage their plant and crop trait capabilities and expertise for the enhancement of attributes related to hemp such as plant content, quality, climate resiliency and yield. Arcadia indicated earlier this year that they were looking to team-up through a collaboration in order to accelerate their anticipated timeline for commercialization of hemp-based products. They quickly delivered on that with the announcement in August of the formation of Archipelago Ventures, a joint venture with Legacy Ventures Hawaii.

Archipelago will be focused on growing, extracting and selling superior sun-grown hemp. The JV will leverage both companies' unique expertise and capabilities to build a complete seed-to-sale supply chain for hemp-derived cannabidiol (CBD) products. By linking ASG's genetic expertise and licensed Hawaiian cultivation facility with Legacy's proven extraction and sales capabilities, Archipelago will have a complete and self-contained CBD supply chain. In addition, Archipelago will have access to Legacy's equity partner, Vapen CBD, a division of publicly traded Vapen MJ Ventures (OTC: VAPNF), which will build and operate Archipelago's Hawaiian hemp extraction facilities.

The long historical status of hemp as a controlled substance in the U.S. meant that related research of the plant had largely been off-limits. This, we think, has created a potentially enormous opportunity for Arcadia given the resultant lack of advancements in genetics of the plant. The recent decriminalization of hemp will likely result in a flurry of competition among cultivators, product developers and other participants in the crop chain to enhance and differentiate their offerings from competitors – and Arcadia is positioning themselves to leverage their expertise in order to capitalize on this upcoming wave of demand for superior hemp strains.

The U.S. Agriculture Improvement Act of 2018 (i.e. the 'Farm Bill') redefined hemp as an agricultural product, thereby opening a potentially enormous new agricultural commodity market in the U.S. While the 2014 Farm Bill legalized hemp only for state-sanctioned research programs, the 2018 Farm Bill completely removed it from regulation under the Controlled Substance Act (regulation is now the responsibility of USDA). Specifically, the Farm Bill (which went into effect on January 1, 2019) separated the definition of hemp from that of marijuana and defined hemp as "the plant Cannabis sativa L. and any part of that plant, including the seeds thereof and all derivatives, extracts, cannabinoids, isomers, acids, salts, and salts of isomers, whether growing or not with a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis." So, while individual states can still regulate (including criminalizing hemp), cultivation of the plant is no longer illegal under U.S. federal statutes.

Arcadia intends to capitalize on this new (legalized market) with hemp representing their initial focus. This includes the development of proprietary germplasm and traits which can be licensed to growers and as products, such as hemp-derived CBD oils (cannabidiol), serving the nutraceutical and food industries. Similar to their other trait programs, ASG anticipates that their value-adds will afford differentiation throughout the crop and food supply chain, ultimately concluding with allowing consumer packaged companies the ability to meaningfully differentiate their products from those of competitors'.

Leveraging Arcadia's expertise for critical product differentiation…

Meaningful product differentiation can be a critical advantage, particularly as an emerging industry becomes more competitive. These capabilities in trait development quickly raised Arcadia's public profile as an emerging leader plant-based genetics and may have played a part in attracting potential partners and in consummating the Archipelago collaboration. Among the benefits of the collaboration with Legacy Ventures Hawaii is access to Vapen CBD and their CBD product marketplace (serving both retail and wholesale customers).

Vapen CBD sells a wide variety of CBD products from their website (vapencbd.com) including vape oil, tinctures and topicals. Vapen CBD touts the organic nature and purity of their ingredients and products – perhaps

acknowledgement of the importance that they place on competitive product differentiation and the value of Arcadia's genetic expertise. Per Vapen CBD's website…

- The "hemp used to make our products is organically grown in the United States without pesticides or herbicides. It's the purest form available and the only form we use."
- "We provide a true form of broad-spectrum cannabinoid extract certified by third parties for purity. We also provide isolates for the ultimate in CBD purity."
- "No GMOs, no fillers, no dyes, no binders, no excipients. We provide pharmaceutical grade CBD products with unequalled purity and quality made in America."
- "Organic ingredients and a superior US-based production process results in Vapen CBD products that are effectively absorbed by your body for fast results."

Vapen CBD's website sells both retail and wholesale



COMPREHENSIVE PRODUCT LINE
A complete line of natural CBD products ideal for most anyone.

Vapen MJ Ventures (Vapen CBD is a wholly owned subsidiary of Vapen MJ Ventures) has implemented an aggressive growth strategy and already witnessed product sales growth of 167% to $6.5M through the first six months of 2019 (from the comparable period in 2018). Also noteworthy, we think, is that their R&D strategy also makes it clear that they place significant value on genetics, with their recent investor presentation highlighting their focus on 'cultivation and extraction', which includes 'genetic development expertise'.[1]

'Genetic Development Expertise' is key to Vapen MJ Ventures' R&D Strategy



Source: Vapen MJ Ventures August Presentation

Hemp / CBD-related revenue expected by year-end and ramp quickly thereafter…
Given the size and growth of the market, CBD oil could represent a significant opportunity for Arcadia. Their demonstrated ability to increase GLA content from 0% to 75% in safflower production could have applicability in leveraging similar opportunities in the CBD market - specifically, improving the CBD oil content in hemp.

[1] Vapen MJ Ventures August 2019 Investor Presentation

Initial activities have already begun in the state of Hawaii where Arcadia has leased 10 acres of land for hemp cultivation. In March 2019 the company was granted a license by Hawaii's Department of Agriculture for that state's Industrial Hemp Pilot Program (HIHPP) which allows for the cultivation of industrial hemp for agricultural and academic research purposes. Focus will be to assess how geography and climate can influence certain crop outcomes (across a variety of local strains) such as yield and overall quality – as well as to demonstrate that they can produce hemp that is compliant with Hawaii's regulations.

The license also allows hemp grown under this program to be commercially sold. Management noted that their initial hemp harvest (from plantings in early April) went well and achieved "multiple breeding milestones". Success of this initial harvest is expected to lead to additional hemp breeding activities over the coming months and, per comments on the Q2'19 call (in August), Arcadia now also has a near-term revenue opportunity related to the production of high quality seeds of select varieties and for specific geographic regions.

As it relates to Archipelago, Arcadia noted that they are already preparing for commercialization and scale up. Near-term, they expect to expand their total hemp production acreage under the Hawaii hemp pilot program – which then is expected to be transitioned to the 2018 Farm Bill through the Hawaii Department of Agriculture Guidelines (which RKDA anticipates happening over the next 12 to 18 months). With their first hemp harvest completed and expectations that Archipelago's extraction facilities are operational in the coming months, Arcadia anticipates that CBD oil sales could commence by current year-end (contingent on regulatory authorization) and ramp quickly thereafter.

Rapid growth of hemp-derived products market…
New markets and rapidly growing interest in hemp and hemp-derived end products such CBD have been catalyzed by federal decriminalization. Research on and use of CBD for a variety of health-related applications (some with more dubious hypotheses than others) has blossomed and facilitated demand that the Brightfield Group forecasts will grow from approximately $590M in 2018 to $22B by 2022, reflecting a four-year CAGR of almost 150%. The outlook for ramping growth of the CBD space is largely supported by other industry watchers including Fior Markets which, according to their internal forecasts, expects the global cannabidiol market to grow from what they estimate to be $1.4B in 2018 to $17.4B by 2026, representing an eight-year CAGR of 36%. The U.S., according to Fior, represents nearly 50% of the worldwide market for CBD. Fior sees growth in consumer spending on CBD products, including edibles and vapes products, and increasing use of CBD in medical applications as key catalysts driving demand.

Verdeca LLC: *HB4 Drought Tolerant Soybeans*
Verdeca LLC is a joint-venture between Arcadia and Bioceres, Inc, an Argentinian-based "fully-integrated provider of crop productivity solutions, including seeds, seed traits, seed treatments, biologicals, high-value adjuvants and fertilizers." Verdeca is focused on the development and deregulation of HB4, proprietary genetically modified drought tolerant soybeans, an annual market estimated at approximately $25B (or ~15% of the ~$150B global market for soybeans). The technology underlying HB4 Drought Tolerant soybeans was discovered by the National Scientific and Technical Research council (in Argentina) and then further developed by Bioceres.

Hb4 Soybeans Field Test



Source: Bioceres, eFarmNews

Multiple seasons of field testing have been completed in both North and South America which showed, among other things, that the HB4 soybeans produced equal to or better yield than control crops. Certain places of the world which are prone to arid growing seasons, such as in specific regions of South America, represent where demand for the HB4 soybeans may be the greatest. As such, Argentina is Verdeca's initial focus growing market. Argentina is the third largest soybean exporter in the world and currently accounts for approximately 5%, or $3B worth, of total global soybean exports.

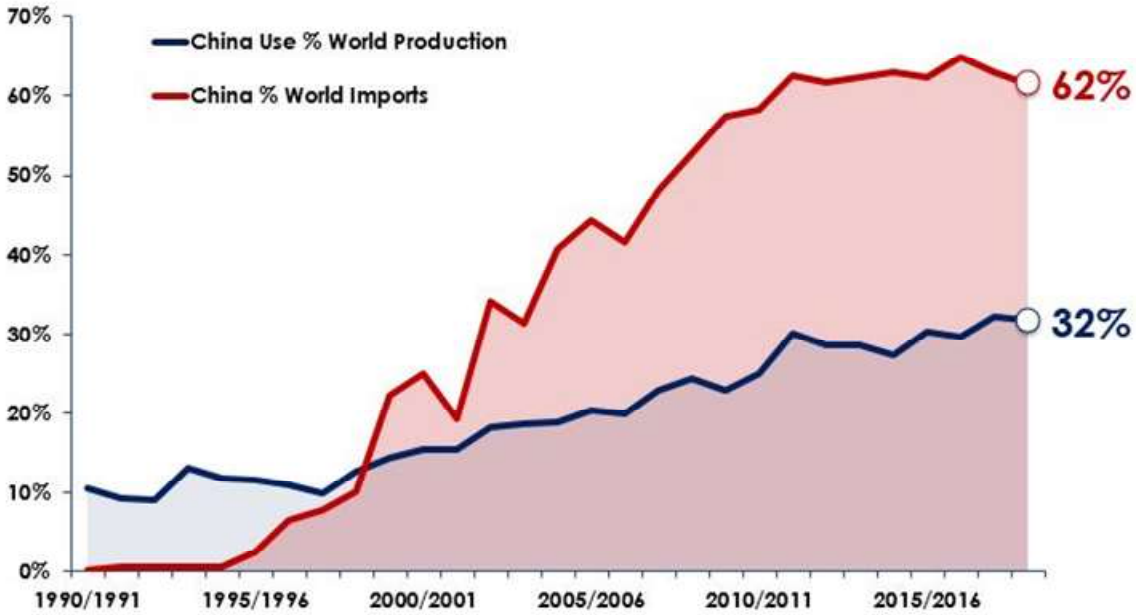
Argentina, and South America more generally, are attractive areas for soybean production for other reasons too – namely the recent U.S./China trade war and China's resultant reduced dependence on U.S. soybean exports. South American countries have been scaling soybean production over the last ten years, which the trade war has further facilitated. According to the U.S. Farm Bureau Federation, soybean production in Brazil, Paraguay and Uruguay has increased by 75%, 52% and 51%, respectively, over the last decade and, along with Argentina, these four countries are projected to export 3.4B bushels of soybeans through the end of 2019 – which is approximately equal to Chinese import demand.

The trait underlying the drought tolerance of the soybeans has approval from Argentinian regulators in regards to food safety and international commerce. The soybeans also need to secure import and regulatory approvals in the countries where they will be consumed. An application seeking U.S. FDA approval was submitted in 2016. The agency completed their review in August 2017, approving the soybeans for food and feed consumption in this country. Then, in August 2019, Verdeca received USDA approval – a major milestone as it allows for commercialization of their HB4 drought tolerant soybeans in the U.S. market. With USDA approval now achieved, Verdeca will begin evaluating potential U.S. germplasm partners for the HB4 trait.

USDA approval follows approval from Brazilian regulators (i.e. National Technical Commission of Biosafety), which was granted in May 2019 and allows for the planting and harvesting of HB4 soybeans (for both drought tolerance and herbicide tolerance traits) in that country. Verdeca has teamed up with Tropical Melhoramiento & Genetica (TMG), a Brazilian soybean and cotton breeding company, to oversee their HB4 programs there.

Regulatory applications have also been submitted, and are currently awaiting approval, in Uruguay and (for import approval in) China. China is both the leading consumer and importer of soybeans, accounting for almost one-third of global consummation and 62% of world imports. Arcadia expects an import approval application to be submitted in the European Union this year. Assuming import approval is secured in China, Arcadia anticipates production scale-up in Argentina and initial launch of their HB4 soybeans happening in China in early 2020.

China's Global Share of Soybean Consumption and Imports



Source: USDA, American Farm Bureau

Verdeca completed the third year of breeding trials of the HB4 soybeans to test drought and herbicide tolerance. The trials are currently being harvested. Verdeca is also increasing seed production to prepare for the anticipated launch in early 2020. As 80% of soybean worldwide production happens in North and South America, Verdeca's initial production territory (i.e. Argentina) could provide not only a meaningful revenue opportunity but also build awareness of the benefits of the soybeans among some of the world's leading growers.

Importantly, initial feedback from farmers appears to be very positive. In late-March Arcadia announced that more than 1,200 attendees toured the Verdeca pavilion where the drought-tolerant HB4 soybeans were showcased to growers at Expoagro, Argentina's largest farm show. Field plots at the event highlighted the effectiveness of the soybeans to not only tolerate extreme drought but to also provide resistance to glufosinate, a broad-spectrum herbicide for weed control. Arcadia noted that they signed up several farmers interested in priority access to test the HB4 soybeans in their own fields.

Corteva AgriScience: *Improved Wheat Quality Trait*
In August 2017 Arcadia entered a strategic collaboration with Corteva Agriscience, the former agricultural unit of DowDuPont which was spun off from the parent in June of this year. Corteva, which trades at a ~$20B market capitalization, brings significant resources, industry-leading expertise, know-how and credibility to the collaboration.

The collaboration will leverage both partners' technologies (including TILLING) towards the development and commercialization of "a breakthrough improved wheat quality trait" in North America. We anticipate that this will include Resistant Starch, Resistant Gluten and extended shelf-life traits.

Corteva will introduce Arcadia's trait into its proprietary germplasm lines and Corteva will be responsible for all commercialization related activities. Development costs will be funded by both parties and proceeds from sales of any commercial products borne from the collaboration will be shared. The program completed initial field trials and is advancing towards the next testing phase. We look forward to hearing more about this program including development related milestone timelines.

SONOVA Safflower Nutritional Oils
Arcadia's SONOVA nutritional oils account for a significant portion of the company's total revenue and are currently the sole contributor to their product sales. Most plant-based oils are lacking in essential nutrients. Arcadia has developed nutritional omega-6 oils made from the safflower plant that take the place of conventional vegetable oils and provide higher levels of important nutrients. RKDA's safflower oils address an annual market estimated to be worth $70M.

SONOVA GLA, developed under a licensing agreement with Abbott Laboratories (ABT), contains the highest concentration of gamma linolenic acid (GLA) of any other currently available plant oil. While conventional plant oils contain between 10% and 22% of GLA, SONOVA GLA contains 65% (and Arcadia has developed and commercialized safflower oil containing up to 75% GLA). GLA is an omega-6 fatty acid which has proven anti-inflammatory and other significant health and anti-aging benefits in humans.[2]



Source: sonovagla.com

[2] Kapoor R1, Huang YS. Gamma linolenic acid: an antiinflammatory omega-6 fatty acid. Curr Pharm Biotechnol. 2006 Dec;7(6):531-4.

Yield and Stress Pipeline: *Drought Tolerance, Nitrogen and Water Use Efficiency, Salinity Tolerance*
While Arcadia has a non-transgenic / non-GM wheat yield program built on their TILLING platform, most of their Yield and Stress pipeline relates to GM traits. While Arcadia's main focus today is on non-GM crop development, they have historically been known as a leader in the transgenic development of abiotic traits. The HB4 drought tolerant soybeans are the main program under Arcadia's yield and stress pipeline, which along with 'drought tolerance', also includes traits for 'nitrogen use efficiency' (NUE) as well as for 'water use efficiency' (WUE). As GM crops are relatively heavily regulated (and even completely banned in some countries), there may be significantly less commercial opportunity for Arcadia's yield and stress traits as compared to their non-GM programs. The abiotic traits that they have developed have largely been out-licensed to commercialization partners.

The NUE technology allows crops to more efficiently use nitrogen fertilizer with no compromise to yields. As such, it affords use of less fertilizer (i.e. lower input costs) and/or higher yields if fertilizer levels are unchanged. The NUE technology has been shown to reduce nitrogen fertilizer requirements by 30% to 50% and to increase yields (in several major commodity crops) by more than 10%. As it relates specifically to rice, the technology increased yield at full fertilizer levels by nearly 30% (as compared to parental lines) in paddy low-lands and in the rain-fed up-lands, increased yield by 34% at 50% nitrogen fertilizer levels.

The WUE technology is similar but not the same as that related to 'drought tolerance'. WUE traits allow plants to better tolerate reduced or inconsistent water availability as well as severe drought. Meanwhile, drought tolerance traits allow plants to maintain yields during periods of prolonged water stress. Inconsistent water availability and severe drought are becoming an ever-growing problem across many parts of the globe as a result water shortages and global warming. Arcadia has an exclusive, worldwide license to the WUE technology (in all crops), which was initially developed through a collaborative effort between the University of California, Davis and Technion – Israel Institute of Technology. The technology has undergone field trials in rice, wheat, cotton, peanuts and alfalfa.

Arcadia licensed salinity trait tolerance traits from the University of Toronto, the University of California, Davis, and the National Institute of Agrobiological Sciences. Arcadia has also conducted research funded by USAID related to other salinity tolerance genes. The traits enable plants, such as wheat, rise, soybeans and cotton, to maintain yields when soil salinity is elevated. Testing to-date has shown the salinity tolerance technology may be able to increase yields by more than 30%.

Arcadia has collaborated with Mahyco since 2007 on various programs related to their NUE, WUE and salinity tolerance traits for major crops, particularly rice. Mayhco is a major international seed producer based in India and with a presence in over 20 countries including Vietnam, Indonesia, the Philippines and most recently, parts of Africa. Until recently, Arcadia out-licensed exclusive research and commercialization rights to Mahyco to their NUE, WUE and salinity tolerance traits in certain geographies. Under the agreements Arcadia received an upfront fee and was eligible for subsequent milestones related to regulatory and technical events. Arcadia was also eligible to receive royalties on sales of seeds sold by Mayhco relating to the licensed traits. In December 2017 Mahyco returned licenses for the three technologies in certain geographies (due to a lack of sufficient progress towards attaining deregulation and commercialization). Arcadia is looking to redeploy these licenses to a different licensee.

Arcadia's Technology –

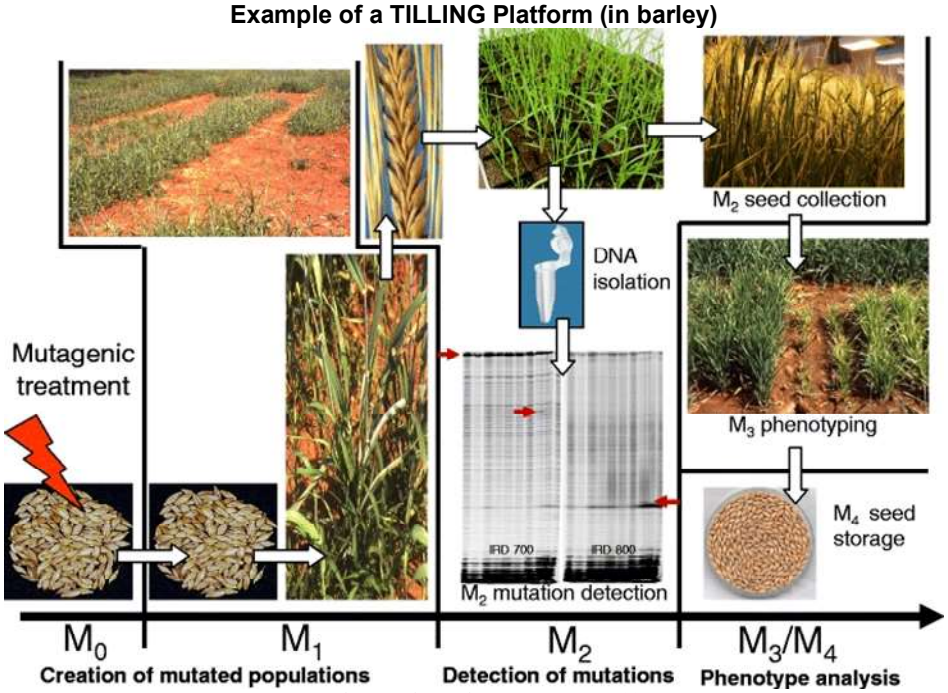
Arcadia's pipeline, particularly as it relates to non-GM traits, represents significant potential revenue opportunity and yet-to-be-realized value. The value of the pipeline was derived from the application of human expertise and cutting-edge trait development technology including TILLING and CRISPR-Cas9.

Importantly, while these technologies make relatively small 'edits' to DNA (of plants, in Arcadia's case) they do not 'modify' DNA (i.e. introduce 'foreign' DNA), the latter which is a much more significant genomic alteration. The difference is important as while genetically modified foods are relatively highly regulated, genetically edited foods are not. As such, the regulatory-related burden (in terms of time, cost and resources expended) of bringing a genetically edited food to market in the U.S. is typically much lower as compared to GM foods. Moreover, several countries, including those in the European Union have effectively banned (with some rare exceptions) new GMOs. (See our 'Regulatory Oversight' discussion, below, for more on this topic).

TILLING is a form of reverse genetics that identifies single-base mutations in genes with the use of a population of diverse plants. Significant strengths of TILLING include that it can be applied to any species regardless of genome size, high throughput and provides for rapid and low-cost discovery of new alleles. TILLING has been used both as a discovery platform as well as for crop breeding as an alternative to transgenic (i.e. GM) methods.[3]

[3] Kurowska. M, et al. TILLING - a shortcut in functional genomics. J Appl Genet. 2011 Nov; 52(4): 371–390.

Example of a TILLING Platform (in barley)

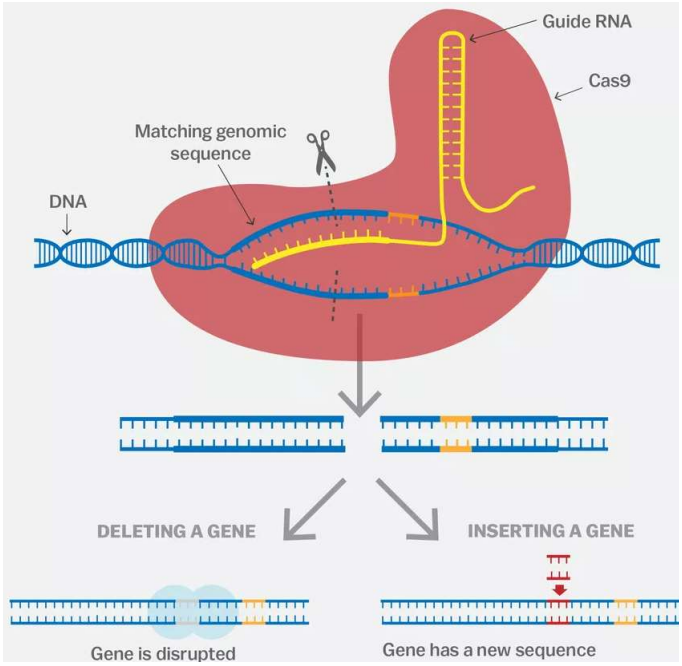


Source: Kurowska, M et al. J Appl Genet. 2011 Nov; 52(4): 371–390.

CRISPR, or clustered regularly interspaced short palindromic repeats, is a gene-editing technology which uses an enzyme and a guide RNA molecule to seek out and cleave (i.e. cut) a gene of interest. Depending on the intended outcome, that gene can be destroyed or be functionally modified.

CRISPR-Cas9, or CRSIPR-associated protein 9, is the most common type of CRISPR used today and describes the use of Cas9 as the cutting enzyme. It uses a specific CRISPR sequence as the guide RNA which searches for DNA strands that are complementary to itself (and which are to be edited). The Cas9 protein then cuts the DNA – at which point the genome can be modified, deleted or new DNA sequences can be inserted. In 2017 Arcadia in-licensed (from the Broad Institute at the Massachusetts Institute of Technology and Harvard University) CRISPR-Cas9 gene-editing technology for research use. CRISPR-Cas9 complements Arcadia's TILLING platform, the combination of which is expected to significantly reduce the time that it takes to bring discoveries to market.

CRISPR-Cas9

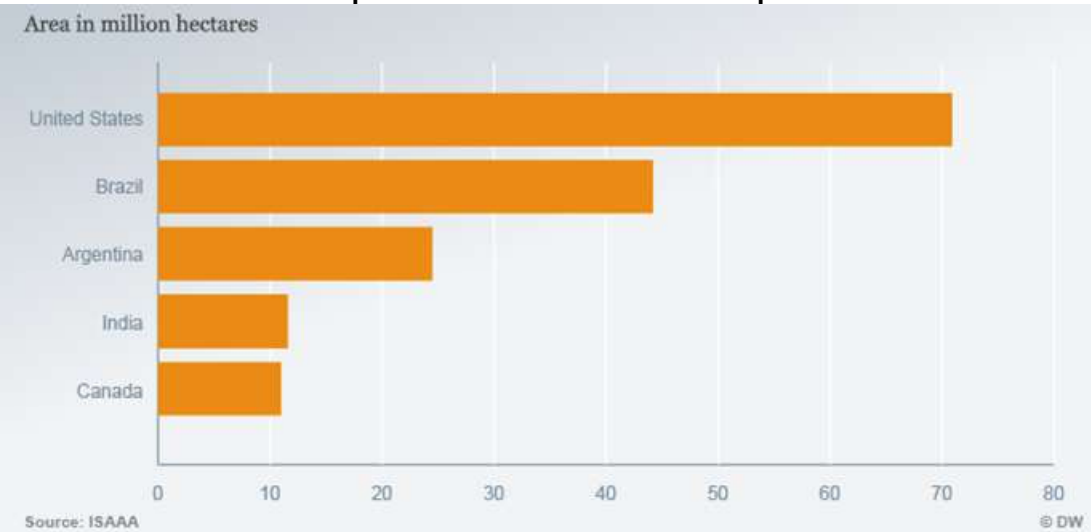


Source: Javier Zarracina, Vox

Regulatory Oversight –

Regulatory oversight relates to GM foods. The U.S. is (by a large margin) the leading producer of GM crops and as of 2017, had 75M hectares of GM crops, or about 40% of the global total (of ~190M hectares). Approximately 90% (or more) of the soybeans, cotton and corn grown in the U.S. are GM and modified for either herbicidal tolerance or insecticidal resistance.

Top 5 Countries with Most GM Crops



Regulatory oversight of GM crops and GM plant-derived food can differ from country-to-county. The U.S., as compared to most other countries, has relatively liberal policies towards GM-related regulations. In the U.S., federal regulatory oversight of GM plants is a function of the USDA (Animal and Plant Health Inspection Service) while oversight of GM food products is a function of the FDA. The U.S. EPA is charged with regulating GM pesticides.

USDA considers most GM plants to be "plant pests" or "potential plant pests" which must receive approval from the agency prior to its introduction. The process for approval first requires the applicant to apply for a permit to field test their material – the permit application requires them to provide a host of information about the donor and recipient organisms, expression of altered genetic material, technology used to develop the plant, intended use and more.

For GM plants that have been tested and shown not to pose a risk, they may be eligible for "nonregulated status". Applying for nonregulated status requires the submission of detailed biological information, scientific studies, field test results and other information pertinent to determining if the plant is a "pest". While guidelines dictate the USDA has 180 days to approve (in whole or part) or deny the petition (which may be extended if they have requests for additional information), average time of the approvals made during 2017 was approximately one year.

FDA's oversight of GM foods largely relates to the provision in the Federal Food, Drug, and Cosmetic Act that requires that any "food additives" be approved by the agency. "Food additives" are defined as "any substance the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food, if such substance is not generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown through scientific procedures to be safe under the conditions of its intended use…"[4]

Note that this definition excludes substances that have been generally recognized as safe (GRAS). The FDA affirmed in a 1992 policy statement that it would treat most cases of foods from GM sources like those from non-GM sources and, therefore, most cases of "food additives" related to GM sources would be considered GRAS. But, for GM products that "differs significantly in structure, function, or composition from substances found currently in food," those products would need to be approved by the FDA as a food additive.

[4] U.S. FDA

The process for the FDA to determine whether approval is required first includes a consultation between the agency and developer to discuss information relevant to the food in the context of safety. More specifically, topics of interest include "significantly increased levels of plant toxicants or anti-nutrients, reduction of important nutrients, new allergens, or the presence in the food of an unapproved food additive." Following the consultation the developer submits a document with information supporting the safety of their product. Additional requests for information from the agency may follow. A completed consultation will acknowledge the safety of the product for food and animal feed. Average time of completion of the consultation process of the 21 consultations that occurred from 2015 to 2017 was just over one year.

International regulatory oversight of GM foods is generally stricter than it is in the U.S. (which is reflective of the graph above). Crops that are grown in the U.S. and intended to be exported must first gain regulatory approval by the importing country. One of the advantages of collaborating with international partners is that Arcadia's partner is typically responsible for the regulatory process in their home country.

OUTLOOK, MODEL ASSUMPTIONS and VALUATION

Management has made rapid progress in redefining the company from previously largely focused on the farmer/seed-company customer segment and reliant on research grants and technology out-licensing to one where they have the opportunity to participate in the more lucrative end of the food chain and consumer products market. While, historically, licensing and contract research and government grants had accounted for a majority of revenue, Arcadia's recent transformation into a consumer products and ingredients company means that an increasing amount of future sales should come from food (and potentially animal feed) and nutritional products that incorporate their proprietary traits.

Importantly, we think Arcadia employed a systematic approach towards choosing which programs that they would pursue in order to realize their intended shift in strategy, focus and growth. Each of their pursuits not only lend themselves to Arcadia's expertise and technology but also have inherent (and in many cases, timely) growth catalysts. This is a critical point, in our opinion, as while it confirms that management knows where the company's competitive advantages lie, it also suggests that they have a deep understanding of (and aim to exploit) micro and macro industry factors (i.e. legal, regulatory, political, economic, climate, global trade, nutrition, consumer preferences, etc, etc) that can have overwhelming influence on dictating what and where the opportunities are.

The company has adeptly used collaborations and partnerships as a way to mitigate risk, share development and regulatory costs and add critical expertise and local (i.e. host country) resources. We expect that collaborations will continue to play a meaningful role in their growth strategy as they climb the food value chain.

Arcadia has built a sizeable patent estate whereby they own or exclusively license 216 patents worldwide across 30 patent families. Leveraging of their patent portfolio and expertise (and technological prowess) in trait development provides them with the ability to gain full control over genetic mutations, thereby affording the relatively unique advantage of obtaining patents on non-GM traits. This, we think, could be critical in not only accelerating the build-out of patent libraries and establishing competitive differentiation but also as a key leverage point as Arcadia seeks to move up the agricultural-food chain.

We review each of the company's major programs and highlight what we think represent potential catalysts that drive long-term, and in some cases near-term, revenue;

- **GoodWheat:**
  - Growth in demand for foods with increased nutritional functionality
    - Mordor Intelligence estimates that the global food fiber market will expand at a 9% CAGR over the next five years and be worth nearly $88B by the year 2024
    - Increasing awareness of the weight loss and overall health benefits of resistant starch are helping to expand the size of this market and accelerate demand growth of resistant starch products
    - In general, function foods (defined by the International Food Information Council as "foods or food components that may provide benefits beyond basic nutrition"), are projected to grow at 6% per year in response to consumer desires for "good for you" foods

        - GoodWheat products have the additional benefit of being intrinsically "good for you" meaning food companies using ingredients based on them can produce simpler, cleaner food labels, without difficult-to-pronounce and complex ingredients, another trend among consumers
    - Growth in demand for foods with reduced allergenicity
        - ~23M Americans (and ~7% of the global population) has gluten sensitivity
        - In addition to those with gluten sensitivity, 26% (or ~80M people) of Americans without gluten sensitivity has expressed interest in reducing gluten from their diets
        - Grand View Research estimates the global gluten-free products market is currently worth ~$18B and projects it to grow at a CAGR of over 9% and reach $32B by 2025
    - Nearing commercialization
        - Counter-season GoodWheat production trials completed earlier this year and subsequently harvested with higher than anticipated yields. Harvest of Spring wheat (planted in Q2) is anticipated to happen in Q3
        - New collaboration between Arcadia, Arista Cereal Technologies and Bay State Milling represents a key milestone towards commercialization of their high fiber resistant starch wheat in North America, Europe and portions of Asia
        - In addition to providing the infrastructure and related capabilities for commercialization, the agreement also eliminates what had been an ongoing patent dispute between Arista and Arcadia
        - Arcadia anticipates commercialization and related revenue of their high fiber wheat to commence this year and expects sales to quickly accelerate beginning in 2020
    - 'Distaste' for GM foods
        - 39% of Americans believe that GM food is less healthy
        - "Overwhelming majority of US consumers believe products containing GMOs should be labeled as such".
        - Poll indicates that; over 90% of people support mandatory labeling of GM foods and ~50% of Americans say they would not eat GM vegetables, fruits and grains
        - GM labeling – as of 2020 food makers will be required by federal law to disclose on some food labels if the contents include GM foods (i.e. "bioengineered' or "BE" food). We think this will further increase demand for non-GM foods (we do note, however, that not all GM food will require labeling)
        - Growth in organic foods is significantly outpacing that of non-organic foods. Organic food sales grew at a CAGR of 9% over the last nine years compared to just 2% for non-organic foods. Foods labeled as 'organic' cannot contain GM products and with the increasing demand for organic foods (as well as increasing interest in natural foods stores), we think this represents another catalyst for GoodWheat

- **Hemp / CBD**
    - Very rapidly growing industry and one that has had relatively little trait innovation to-date – presenting a significant opportunity for Arcadia
        - Market researchers predict the global CBD market will expand at a CAGR as high as 150% over the next four years and be worth as much as $22B by 2022. Even relatively conservative estimates predict an 8-year CAGR of 36%, reflecting a market expansion of $1.4B in 2018 to $17.4B by 2026
        - Deregulation and increasing awareness of the potential health and well-being benefits of CBD is expected to drive growth in consumer spending on CBD products, including edibles and vapes products, and drive use of CBD in medical applications
    - Archipelago JV accelerates commercialization timeline
        - Archipelago links ASG's genetic expertise and licensed Hawaiian cultivation facility with Legacy's proven extraction and sales capabilities to create a complete and self-contained CBD supply chain
        - Archipelago also provides access to Vapen CBD, which will build and operate the JV's Hawaiian hemp extraction facilities. Vapen CBD also has an established marketplace, offering a variety of branded CBD products to both retail and wholesale accounts

- Initial hemp harvest (from plantings in early April) went well and achieved "multiple breeding milestones". Success of this initial harvest is expected to lead to additional hemp breeding activities over the coming months
- Archipelago is already preparing for commercialization and scale up. Near-term goals include expanding total hemp production acreage under the Hawaii hemp pilot program
- With their first hemp harvest completed and expectations that Archipelago's extraction facilities are operational in the coming months, Arcadia anticipates that CBD oil sales could commence by current year-end (contingent on regulatory authorization) and ramp quickly thereafter.
- Arcadia now also has a near-term revenue opportunity related to the production of high-quality seeds of select varieties and for specific geographic regions
- Following three-step hemp strategy
    - Hemp germplasm: RKDA is acquiring samples of U.S. hemp strains across phenotypical and geographic lines representing some of the most productive and highest quality domestic strains in order to build capabilities for developing novel varieties and attributes
    - Hemp breeding: will produce a number of novel varieties focusing on improved agronomical performance and secure IP protection when and where appropriate
    - Trait development: have established gene editing targets of interest (based on customer and market due diligence) and expect to have one or more genetically diverse libraries by early 2020

- **HB4 Soybeans**
    - Multiple seasons of field testing have completed which showed HB4 soybeans produced equal or better yield than control crops
    - Initial feedback from farmers is positive. In late-March Arcadia announced that more than 1,200 attendees toured the Verdeca pavilion where the drought-tolerant HB4 soybeans were showcased to growers at Expoagro, Argentina's largest farm show. Arcadia noted that they signed up several farmers interested in priority access to test the HB4 soybeans in their own fields
    - Regulatory submissions / approvals
        - In August 2019, Verdeca received USDA approval – a major milestone as it allows for commercialization of their HB4 drought tolerant soybeans in the U.S. market. With USDA approval now achieved, Verdeca will now begin evaluating potential U.S. germplasm partners for the HB4 trait
        - In May 2019 Brazilian regulators (i.e. National Technical Commission of Biosafety) granted approval for the planting and harvesting of HB4 soybeans (for both drought tolerance and herbicide tolerance traits) in that country
        - Regulatory applications submitted, and are currently awaiting approval, in Uruguay and (for import approval in) China. Once China import approval is obtained will scale-up production in Argentina
    - China launch (grown in Argentina): predicated on securing import approval in China, that country will represent the initial launch territory of the HB4 soybeans, which is anticipated by early 2020
    - U.S./China trade war: China is the largest user (accounting for ~one-third of global soybean demand) and worldwide importer of soybeans with approximately 35%, or $13B, of their soybean imports coming from the U.S. The U.S./China trade war, which increased China's U.S.-sourced soybean costs by 25%, has resulted in China importing more soybeans from other countries (including Brazil, the world's largest soybean exporter). While U.S. soybean exports to China fell by 50% (and has since ceased altogether), demand from Brazil grew 30%.[5] While China is in the midst of expanding their domestic soybean production in order to reduce reliance on imports, there remains a significant and valuable market for soybean production and we expect, once China import approval is secured, that demand for the HB4 soybeans (from Argentina) will similarly benefit from the trade war

- **SONOVA Nutritional Oils**
    - Arcadia has noted that they have received interest from several additional potential customers which have indicated that they may be interested in using their GLA oil for products such as foods, other dietary supplements and medical products

[5] South China Morning Post. *The US-China trade war has been a boon for Brazil's soybean farmers. But can they keep up with Chinese demand?* May 17, 2019

- While SONOVA GLA has been used in dog and cat food in Canada since 2015, the pet market has yet to materialize as a significant area of growth for the product. In August 2017 and February 2019 FDA approved the use of SONOVA GLA in dog food and in cat food in the U.S., which could provide a more substantial opportunity for the product in this large and growing market segment. Worldwide pet food sales reached $91B, including $32B in the U.S., in 2018 and are growing at a CAGR of 6%.
- While we do not view SONOVA GLA Oils as a growth segment in and of itself, we do think there is significant value in the underlying technology and Arcadia's proven capabilities in increasing GLA content – those capabilities could have broad applicability in other areas (such as with CBD oils).

➢ **Political / Government / NGO influences**
- Biofuels: as biofuels consume relatively enormous amounts of crops, such as corn, if their popularity grows, so will the need for crop innovation. Biofuel demand has largely been a consequence of politics and legislation
- Tariffs – agricultural tariffs could be a boon for crop trait development as importing countries look to increase domestic yield and production moves/increases in non-tariff-affected exporting countries (which may not have ideal growing conditions)
- International aid programs:
  - International aid programs focused on feeding the poor in underdeveloped parts of the world represent a potentially significant driver of demand for novel yield and abiotic stress traits such as Arcadia's drought tolerance traits and nitrogen use and water use efficiency traits
  - According to the World Bank, development of the agricultural sector is fundamental to Africa's overall economic development and poverty reduction
  - According to the World Bank and KPMG, increasing yields for staple crops such as rice and wheat in areas of the world such as Africa will be critical to reducing starvation. Also, lack of local food production and a 1% increase in crop yields results in a 0.5% to 0.8% reduction in poverty

➢ **Climate Change**
- Scientists believe that climate change will increase the volatility in the amount of food grown each year and global warming will migrate food production towards what are now relatively colder climates
- This should increase demand for abiotic stress traits
- Abiotic stress traits account for 80% of wheat yield loss and 65% of corn yield loss and these abiotic stresses are addressed by Arcadia's NUE, WUE, drought tolerance and salinity tolerance traits
- A recent example of the potential influence that climate change can have on demand for abiotic stress traits happened in May 2019 when drought forced Australia to make its first wheat import (from Canada) in a decade

➢ **Migrating forward in ag-food supply chain**
- Moving from the farmer and seed company to consumer food company
- Bulk of RKDA's revenue should begin to move away from contract research agreements and government grants and towards product sales on the heels of commencement of commercialization of their nutritional ingredient traits
- By moving towards the end of the food chain, Arcadia positions themselves in the more lucrative, less price-sensitive and higher margin portion of the market

Valuation

Having laid the groundwork for growth and on the cusp of three key product launches, in late-August management issued initial financial guidance. This includes expectations of generating revenue in excess of $10M and $30M in 2020 and 2021, respectively, and reaching a point of positive cash flow from operations by mid-to-late 2021.

Our projections, the general bases behind which we explain below, imply a slightly more conservative, yet still robust, near-term revenue curve. The lack of commercial history for each of RKDA's specific products means that financial forecasts are essentially best guesses at this point.

We note that we already had our financial model constructed prior to the early-August announcement of the Archipelago joint venture – which also preceded announcements related to HB4 USDA approval, the resistant starch wheat collaboration with Arista/Bay State and the positive operational update as covered in the Q2'19

earnings announcement (and conference call). Most of these developments materialized sooner than we had been anticipating. So, while the bulk of our model remains unchanged from our initial iteration (which also predated RKDA's guidance), we have moved up the estimated timeline for when we believe revenue will begin to scale.

That is a roundabout way of explaining that our projections were constructed before RKDA issued guidance. Our numbers should also not be interpreted as implying that we believe management's guidance is optimistic or unlikely to be attainable. In addition, our model should always be assumed to be subject to change and influenced by any delta between our assumptions and how reality plays out.

We use a 10-year DCF model to value RKDA. Our DCF models the RS/RG wheat, hemp/CBD, HB4 soybeans and SONOVA GLA programs. We do not currently include the company's yield and stress pipeline (i.e. aside from the HB4 soybeans) as we feel the heavily regulated nature of GM crops may impede further development and commercialization progress and potentially constrain the overall market opportunity for these offerings. However, this, like all our assumptions, are subject to updating.

We incorporate the following per-program market assumptions (see Market Penetration Forecast, below);

RS/RG Wheat
Initial addressable market size equal to approximately $9B to $10B and increasing at a CAGR of 8.5%, or inline with market researchers' forecasts, to ~$23B by 2029. We model just 0.125% market penetration by 2021 with growth driven by increasing demand for low-gluten, resistant starch products and just under 1.0% market penetration by year 2029. This equates to RS/RG wheat revenue of $14.4M in 2021 and growing to $208.0M in 2029.

Hemp/CBD
Initial addressable market size equal to approximately $1B and increasing at a CAGR of 93%, or the average of the (referenced) industry growth forecasts, through 2024 and then growing at an annual rate of 5% through 2029. We model just 0.15% market penetration by 2021 with growth driven by deregulation and increasing demand from both consumer and healthcare applications and 0.37% market penetration by year 2029. This equates to hemp/CBD related revenue of $5.5M in 2021 and growing to $126.9M in 2029.

HB4 Soybeans
Initial addressable market size equal to approximately $25B (or ~15% of the ~$150B global market) and increasing at a CAGR of 5%, commensurate with market researchers' forecasts, to $41B by 2029. We model just 0.011% market penetration by 2021 with growth driven by regulatory approvals, particularly robust demand from relatively arid production environments and China's diminishing reliance on U.S. soybean exports, and 0.525% penetration by 2029. This equates to HB4 related revenue of $2.9M in 2021 and growing to $213.8M in 2029.

SONOVA GLA Oils
Initial addressable market size equal to approximately $70M and increasing at a CAGR of 2.5% to $90M by 2029. We have market penetration, which currently stands at about 1%, growing very modestly to 2.2% in 2029. While we do not view SONOVA GLA Oils as a growth segment in and of itself, we do think there is significant value in the underlying technology and Arcadia's proven capabilities in increasing GLA content – those capabilities could have broad applicability in other areas (such as with CBD oils). This equates to SONOVA GLA oil revenue of $1.0M in 2021 and growing to $2.0M in 2029.

Our DCF, which uses a 12.5% discount rate and 1.5% terminal growth rate, values RKDA at approximately $12/share on a fully diluted basis (our share count includes the registered direct offering of 1.32M common shares announced today (September 6th) and expected to close by September 10th). Our $12/share DCF-derived price target implies a price-to-2021 sales ratio of approximately 8x (discounted back to present at 10%/year) – which, given the anticipated relatively very steep growth rate, is reasonable (or arguably, conservative) in our opinion.

MARKET PENETRATION FORECAST

Arcadia Biosciences, Inc.

Markets ($000)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Wheat	$9,700,000	$10,573,000	$11,524,570	$12,561,781	$13,692,342	$14,924,652	$16,267,871	$17,731,979	$19,327,858	$21,067,365	$22,963,428
Hemp/CBD	$1,000,000	$1,930,000	$3,724,900	$7,189,057	$13,874,880	$26,778,518	$28,117,444	$29,523,317	$30,999,482	$32,549,457	$34,176,929
Hb4 Soybeans	$25,000,000	$26,250,000	$27,562,500	$28,940,625	$30,387,656	$31,907,039	$33,502,391	$35,177,511	$36,936,386	$38,783,205	$40,722,366
SONOVA GLA	$70,000	$71,750	$73,544	$75,382	$77,267	$79,199	$81,179	$83,208	$85,288	$87,420	$89,606

Mrkt penetration	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Wheat	0.0%	0.031%	0.125%	0.336%	0.437%	0.581%	0.639%	0.730%	0.779%	0.817%	0.906%
Hemp/CBD	0.0%	0.059%	0.148%	0.261%	0.215%	0.175%	0.215%	0.242%	0.288%	0.346%	0.371%
Hb4 Soybeans	0.0%	0.004%	0.011%	0.028%	0.053%	0.088%	0.140%	0.175%	0.280%	0.350%	0.525%
SONOVA GLA	1.1%	1.250%	1.410%	1.520%	1.612%	1.714%	1.821%	1.915%	2.001%	2.141%	2.225%

Revenue ($000)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Wheat	0.0%	$3,243.7	$14,368.6	$42,192.0	$59,802.9	$86,671.4	$103,923.4	$129,528.6	$150,639.9	$172,133.3	$208,013.9
Hemp/CBD	0.0%	$1,132.3	$5,525.7	$18,744.1	$29,795.2	$46,754.0	$60,457.7	$71,360.4	$89,331.9	$112,630.2	$126,887.4
Hb4 Soybeans	0.0%	$918.8	$2,894.1	$8,103.4	$15,953.5	$27,918.7	$46,903.3	$61,560.6	$103,421.9	$135,741.2	$213,792.4
SONOVA GLA	$752.5	$896.9	$1,037.0	$1,145.8	$1,245.5	$1,357.5	$1,478.3	$1,593.8	$1,706.9	$1,871.7	$1,993.9
Total	**$753**	**$6,192**	**$23,825**	**$70,185**	**$106,797**	**$162,702**	**$212,763**	**$264,043**	**$345,101**	**$422,376**	**$550,688**

Brian Marckx, CFA. Zacks Small-Cap Research

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Arcadia Biosciences, Inc

RKDA	2018 A	Q1A	Q2A	Q3E	Q4E	2019 E	2020 E	2021 E
Product sales	$0.7	$0.1	$0.2	$0.2	$0.4	$0.9	$6.2	$23.8
YOY Growth	*27.8%*	*75.4%*	*-14.9%*	*38.9%*	*51.5%*	*32.0%*	*614.1%*	*284.8%*
% total sales	*44.9%*	*67.7%*	*79.6%*	*80.0%*	*88.9%*	*81.9%*	*98.4%*	*100.0%*
License revenue	$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
YOY Growth	*-89.8%*	-	-	-	-	-	-	-
% total sales	*10.2%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Contract research & govt grants	$0.7	$0.1	$0.0	$0.1	$0.1	$0.2	$0.1	$0.0
YOY Growth	*-67.8%*	*-66.7%*	*-74.1%*	*-76.9%*	*-61.5%*	*-70.8%*	*-47.9%*	*-100.0%*
% total sales	*44.9%*	*32.3%*	*20.4%*	*20.0%*	*11.1%*	*18.1%*	*1.6%*	*0.0%*
Total Revenue	$1.5	$0.2	$0.2	$0.3	$0.5	$1.1	$6.3	$23.8
YOY Growth	-	-	-	-	-	*-27.7%*	*494.1%*	*278.7%*
Cost of Goods Sold	$0.7	$0.1	$0.1	$0.1	$0.2	$0.4	$2.0	$6.1
Gross Income	$0.8	$0.1	$0.1	$0.2	$0.3	$0.7	$4.3	$17.7
Gross Margin	*54.8%*	*62.7%*	*55.7%*	*63.2%*	*64.7%*	*62.3%*	*68.1%*	*74.2%*
R&D	$6.1	$1.5	$2.0	$2.1	$2.1	$7.7	$8.7	$9.5
%R&D	*414.5%*	*952.5%*	*970.1%*	*840.0%*	*466.7%*	*722.9%*	*138.3%*	*39.9%*
SG&A	$11.6	$2.8	$3.1	$3.3	$3.7	$12.9	$17.4	$22.7
% SG&A	*792.6%*	*1779.7%*	*1564.7%*	*1325.0%*	*817.8%*	*1222.8%*	*276.8%*	*95.3%*
TOTAL OpEx	**$17.7**	**$4.3**	**$5.1**	**$5.4**	**$5.8**	**$20.6**	**$26.1**	**$32.2**
% Total OpEx	*1207.2%*	*2732.3%*	*2534.8%*	*2165.0%*	*1284.4%*	*1945.6%*	*415.1%*	*135.2%*
Operating Income	($16.9)	($4.2)	($5.0)	($5.3)	($5.5)	($19.9)	($21.8)	($14.5)
Operating Margin	*-1152.3%*	*-2669.6%*	*-2479.1%*	*-2101.8%*	*-1219.7%*	*-1883.3%*	*-347.0%*	*-61.0%*
Total Other Income (Expense)	$3.4	($8.4)	$9.2	($0.2)	$0.4	$1.0	$0.3	($2.5)
Pre-Tax Income	($13.5)	($12.6)	$4.2	($5.4)	($5.1)	($18.9)	($21.6)	($17.0)
Income tax expense (benefit)	$0.0	$0.0	($0.0)	$0.0	$0.0	$0.0	$0.0	$0.0
Tax Rate	*-0.1%*	*-0.2%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Net Income	($13.5)	($12.6)	$4.2	($5.4)	($5.1)	($18.9)	($21.6)	($17.0)
YOY Growth	*-14.2%*	*18.6%*	*-163.5%*	*-221.4%*	*718.3%*	*40.4%*	*14.1%*	*-21.1%*
Net Margin	*-920.8%*	*-7982.3%*	*2107.5%*	*-2161.8%*	*-1142.0%*	*-1786.5%*	*-343.0%*	*-71.5%*
EPS (GAAP)	($3.58)	($2.64)	$0.84	($0.82)	($0.68)	($3.15)	($2.54)	($1.31)
YOY Growth	*-50.9%*	*-45.7%*	*-141.6%*	*-188.3%*	*416.5%*	*-11.9%*	*-19.5%*	*-48.5%*
Shares O/S	3.8	4.8	5.1	6.6	7.6	6.0	8.5	13.0

Brian Marckx, CFA

LEADERSHIP[6]

Management –

Matthew Plavan
President and Chief Executive Officer
Matthew Plavan was appointed president and chief executive officer in September 2019. He joined Arcadia as chief financial officer three years earlier and most recently, also served as president of Arcadia Specialty Genomics, a strategic business unit delivering innovations in hemp. Prior to joining Arcadia, Mr. Plavan served as CEO and board member of Cesca Therapeutics, Inc., and COO of ThermoGenesis Corp. He also led the finances, as CFO, of two high-tech private equity backed companies, positioning each for successful exits, following senior management tenures at both McKesson and Ernst & Young, LLC. Mr. Plavan is a certified public accountant and earned a bachelor's degree in business economics from the University of California, Santa Barbara.

Sarah Reiter
Chief Commercial Officer
Sarah Reiter joined Arcadia as chief commercial officer in March 2018. She has over 20 years of experience in agriculture with a strong focus on crop protection and sustainability. Prior to joining Arcadia, Ms. Reiter was the USA country head for STK Bio-ag Technologies and global product manager for biologics for Bayer CropScience. She previously served as vice president of marketing and communications for AgraQuest and served in several positions with Syngenta USA. Ms. Reiter holds a bachelor's degree in English from the University of California, Davis and a master's certificate in business administration from the Villanova School of Business.

Pam Haley
Chief Financial Officer
Pam Haley was appointed chief financial officer for Arcadia in September 2019. She was formerly the controller for the company and has served in various accounting management positions since joining Arcadia in 2005. Ms. Haley has over 25 years of financial and accounting experience and worked in the telecommunications and semiconductor industries, in addition to public accounting, prior to joining Arcadia. She is a certified public accountant and a graduate of the University of Arizona, where she earned a bachelor's degree in accounting.

Randall Shultz, Ph.D
Head of Research & Development
Randall Shultz, Ph.D. joined Arcadia as head of research and development in April 2019. He was formerly the global crop lead at Inari Agriculture, where he also served as the director of R&D and senior director of R&D strategy. Before Inari, Dr. Shultz spent several years leading various scientific production teams at Monsanto (now Bayer Crop Science), including their Genome Editing Platform team. He received his Ph.D. in functional genomics from North Carolina State University and his B.S. degree from the University of Wisconsin, Madison. He has authored over a dozen patents and publications.

Grant Aldridge
Head of Commercial Operations
Grant Aldridge joined Arcadia in September 2018 as head of commercial development leading operations for GoodWheat™ seed and grain production. He brings 30 years of crop production experience executing new market models for high-value traits and attributes in corn, soybeans, wheat, and specialty vegetable crops. Prior to joining Arcadia, Mr. Aldridge held senior leadership positions with several biotech start-ups developing and introducing novel industrial crops. He previously was with Syngenta for 11 years in both crop protection and seeds divisions serving in brand management, marketing, sales, operations and agronomy positions. He received his M.S. degree in plant genetics and breeding from Purdue University and his B.S. degree in crop science from Texas Tech University.

Chris Williams-Campbell
Head of People, Facilities and Information Technology
Chris Williams-Campbell has been Arcadia's head of human resources, facilities and IT since November of 2016. As a broadly skilled HR management generalist, Mr. Williams-Campbell has spent the past 25 years in leadership positions with companies in the agricultural biotech, pharmaceutical, medical device and transportation industries, including Mendel Biotechnology, Limagrain, Volcano Corporation, ALZA Corporation and United Parcel Service. With expertise in talent, leadership and organizational development, he leads all facets of Arcadia's people operations. Mr. Williams-Campbell holds a B.A. in history from the University of California, Davis.

[6] Per Arcadia Biosciences corporate website

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Board of Directors –

Kevin Comcowich
Chairman of the Board
Kevin Comcowich is chair of Arcadia's board of directors and has served as a director since October 2016. Mr. Comcowich brings extensive business and financial leadership experience and a proven track record of success in investment management and global capital market strategies. He most recently served as the chief executive officer and portfolio manager of HTX Energy Fund in Houston, Texas. He was previously the president and chief investment officer (CIO) of Sound Energy Partners and served as CIO and research analyst for Southport Energy Plus Partners fund. Mr. Comcowich received his MBA from the University of Indiana and earned his bachelor's degree from the College of the Holy Cross.

Albert D. Bolles, Ph.D.
Albert D. Bolles, Ph.D. joined the board of directors in May 2018. He most recently served as the executive vice president, chief technology and operations officer of ConAgra Foods, a leading consumer products food company, where he directed the development and execution of multiple product innovations. Prior to ConAgra, Dr. Bolles was the vice president of worldwide research and development for PepsiCo Beverages and Foods and the research and development director for Gerber Foods. He is a graduate of Michigan State University, where he earned Ph.D. and M.S. degrees in food science and a bachelors' degree in microbiology. Dr. Bolles holds several patents and has won numerous awards for his contributions to food science, the industry and academics. He currently serves as a director for Landec Corporation.

Matthew Pavlin
(bio above)

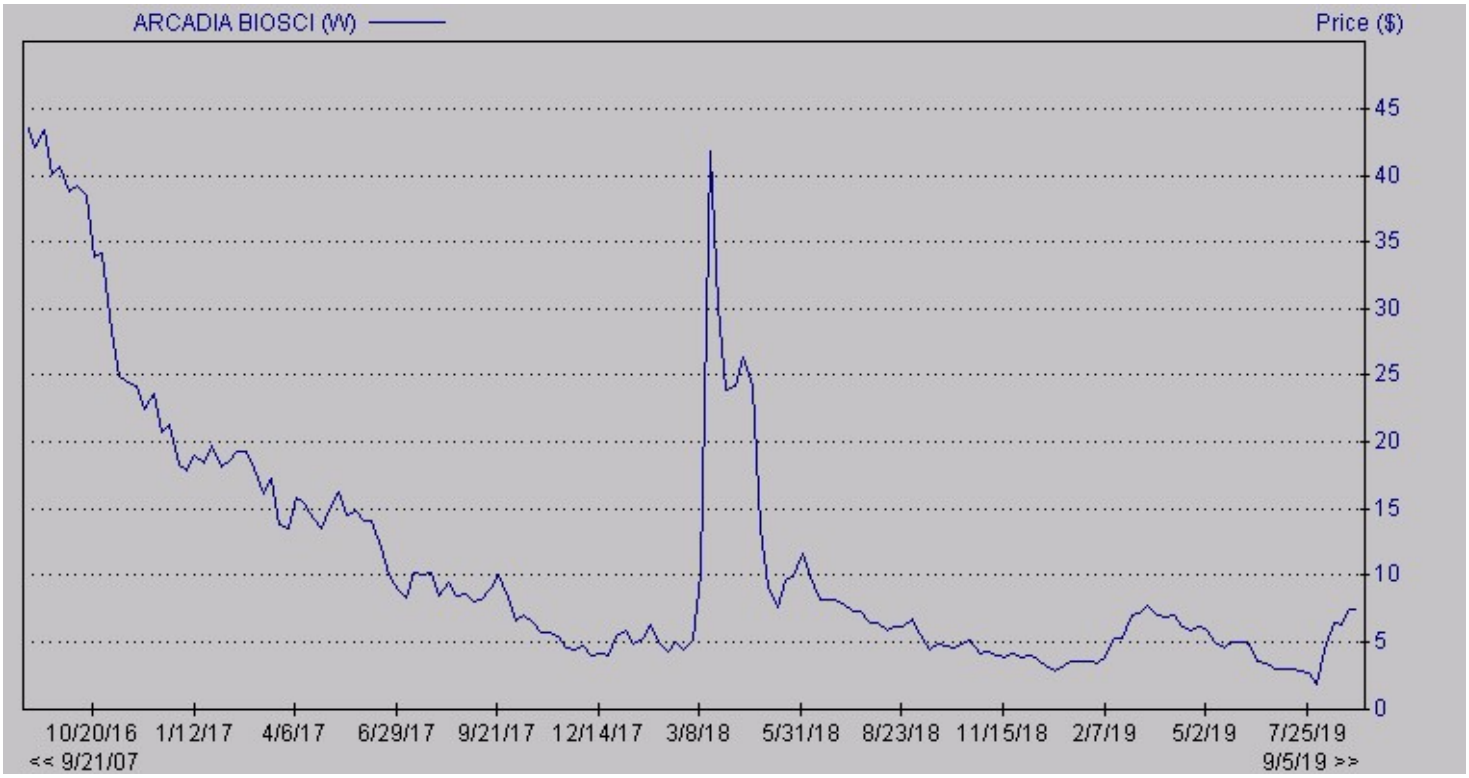
Eric J. Rey
Eric J. Rey joined the board of directors in June 2017. He is one of the founders of Arcadia Biosciences and served as president and CEO, as well as a director, until 2016. Prior to founding Arcadia, Mr. Rey was a partner with Rockridge Group, a management consulting firm for early-stage companies developing genomic, biopharmaceutical, nutraceutical, crop protection, animal nutrition and health, alternative crop and industrial products. He previously served as vice president of operations with Calgene, Inc., including two years with Monsanto Company following its acquisition of Calgene. Mr. Rey has a bachelor's degree in plant science from the University of California, Davis. He currently serves as a director for Phytelligence, Inc. and Texas Crop Science, LLC.

Lilian Shackelford Murray
Lilian Shackelford Murray joined the board of directors in June 2018 and previously served as an observer to the Arcadia board from March 2007 until May 2015. Ms. Murray is the founder and manager of Dovedale Investments and managing member of Saints Capital V. She is a former managing director and senior healthcare banker at Prudential Volpe Technology Group and its predecessor, Volpe, Brown Whelan, and held senior positions with Wheat First Securities and Dean Witter Reynolds. Ms. Murray received an MBA from Harvard Business School and a bachelor's degree from the University of Virginia. Her prior board experience includes service as a director of eMedicine.com, Inc., Extended Care Information Network, Inc. and LifeMasters Supported SelfCare, Inc.

Gregory D. Waller
Gregory D. Waller joined Arcadia's board of directors in June 2017. He is the former chief financial officer (CFO) of Ulthera Corporation, a privately-held company providing ultrasound technology for aesthetic and medical applications, which was acquired by Merz North America in 2014. Previously, Mr. Waller was CFO of Universal Building Products and Sybron Dental Specialties, Inc., and vice president and treasurer of Kerr, Ormco Corporation, and Metrex. Mr. Waller has an MBA with a concentration in accounting from California State University, Fullerton. He has extensive experience serving on the boards of public companies and currently serves as a director for CHF Solutions and Endologix Corporation.

Amy Yoder
Amy Yoder joined the Arcadia board in August 2017. She is president and CEO of Anuvia Plant Nutrients, a company that creates enhanced plant nutrition products from recycled organic waste sources. Ms. Yoder is the former president of Arysta LifeScience and has held a variety of sales, marketing and executive positions with companies throughout the agricultural and related industries, including Spectrum Brands, BioLab and United Agri Products. Ms. Yoder received a bachelor's degree in agricultural technology and systems management from Michigan State University. She has served on boards of various agricultural associations and universities and currently serves as a director for Compass Minerals International.

HISTORICAL STOCK PRICE



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