UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the fiscal year ended December 31, 2018

OR

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934 FOR THE TRANSITION PERIOD FROM TO**

Commission File Number 001-37383

Arcadia Biosciences, Inc.

(Exact name of Registrant as specified in its Charter)

Delaware	**81-0571538**
(State or other jurisdiction of incorporation or organization)	**(I.R.S. Employer Identification No.)**
202 Cousteau Place, Suite 105 Davis, CA	**95618**
(Address of principal executive offices)	**(Zip Code)**

(530) 756-7077
(Registrant's Telephone Number, Including Area Code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	**Name of each exchange on which registered**
Common Stock, par value $0.001 per share	**The NASDAQ Capital Market**

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark if the Registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. YES ☐ NO ☒

Indicate by check mark if the Registrant is not required to file reports pursuant to Section 13 or 15(d) of the Act. YES ☐ NO ☒

Indicate by check mark whether the Registrant: (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the Registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. YES ☒ NO ☐

Indicate by check mark whether the Registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§232.405 of this chapter) during the preceding 12 months (or for such shorter period that the Registrant was required to submit such files). YES ☒ NO ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K (§229.405) is not contained herein, and will not be contained, to the best of Registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer	☐	Accelerated filer	☐
Non-accelerated filer	☐	Smaller reporting company	☒
Emerging growth company	☒		

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☒

Indicate by check mark whether the Registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). YES ☐ NO ☒

The aggregate market value of the voting and non-voting common equity held by non-affiliates of the Registrant as of June 30, 2018, the last business day of the Registrant's most recently completed second fiscal quarter, was approximately $39,400,000 (based on the closing price of $8.25 on June 30, 2018 on the NASDAQ Capital Market).

The number of shares outstanding of the Registrant's common stock on March 7, 2019, was 4,777,419 shares.

DOCUMENTS INCORPORATED BY REFERENCE

Information required by Part III of this Annual Report on Form 10-K is incorporated by reference to the Registrant's Definitive Proxy Statement for its 2019 Annual Meeting of Stockholders, which proxy statement will be filed with the Securities and Exchange Commission within 120 days after the end of the fiscal year covered by this Form 10-K.

INTRODUCTION

"Arcadia," the "Company," "we," "our" and "us" are used interchangeably to refer to Arcadia Biosciences, Inc. and its subsidiary.

SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report on Form 10-K contains forward-looking statements within the meaning of the federal securities laws, which statements involve substantial risks and uncertainties. Forward-looking statements generally relate to future events, our future financial or operating performance, growth strategies, anticipated trends in our industry, and our potential opportunities, plans, and objectives. In some cases, you can identify forward-looking statements because they contain words such as "may," "will," "should," "expects," "plans," "anticipates," "could," "intends," "target," "projects," "contemplates," "believes," "estimates," "predicts," "potential," or "continue" or the negative of these words or other similar terms or expressions that concern our expectations, strategy, plans, or intentions. Forward-looking statements contained in this Annual Report on Form 10-K include, but are not limited to, statements about:

- our or our collaborators' ability to develop commercial products that incorporate our traits and complete the regulatory process for such products;
- our ability to earn revenues from the sale of products that incorporate our traits;
- our ability to maintain our strategic collaborations and joint ventures and enter into new arrangements;
- estimated commercial value for traits;
- market conditions for products, including competitive factors and the supply and pricing of competing products;
- compliance with laws and regulations that impact our business, and changes to such laws and regulations;
- our ability to license patent rights from third parties for development as potential traits;
- our ability to maintain, protect, and enhance our intellectual property;
- our future capital requirements and our ability to satisfy our capital needs;
- industry conditions and market conditions;
- the preceding and other factors discussed in Part I, Item 1A, "Risk Factors," and other reports we may file with the Securities and Exchange Commission from time to time; and
- the factors set forth in Part II, Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations."

We caution you that the foregoing list may not contain all of the forward-looking statements made in this Annual Report on Form 10-K.

You should not rely upon forward-looking statements as predictions of future events. We have based the forward-looking statements contained in this Annual Report on Form 10-K primarily on our current expectations and projections about future events and trends that we believe may affect our business, financial condition, results of operations and prospects. The outcome of the events described in these forward-looking statements is subject to risks, uncertainties and other factors described in the section titled "Risk Factors" and elsewhere in this Annual Report on Form 10-K. Moreover, we operate in a very competitive and rapidly changing environment. New risks and uncertainties emerge from time to time and it is not possible for us to predict all risks and uncertainties that could have an impact on the forward-looking statements contained in this Annual Report on Form 10-K. We cannot assure you that the results, events and circumstances reflected in the forward-looking statements will be achieved or occur, and actual results, events or circumstances could differ materially from those described in the forward-looking statements.

The forward-looking statements made in this Annual Report on Form 10-K relate only to events as of the date on which the statements are made. We undertake no obligation to update any forward-looking statements to reflect events or circumstances or to reflect new information or the occurrence of unanticipated events, except as required by law.

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PART I

Item 1. Business.

Overview

We are a consumer-driven, agricultural food ingredient company. We aim to create value across the agricultural production and supply chain beginning with enhanced crop productivity for farmers and ultimately delivering accelerated innovation in nutritional quality foods to consumers. We use state of the art gene-editing technology and advanced breeding techniques to naturally enhance the nutritional quality of grains and oilseeds to address the rapidly evolving trends in consumer health and nutrition. In addition, we have developed a broad pipeline of high value crop productivity traits designed to enhance farm economics.

Consumers are demanding healthier, high quality foods, naturally and sustainably produced with greater ingredient simplicity, and transparency from food companies. Now more than ever, consumers are paying premium pricing to satisfy their dietary health requirements, such as higher fiber and lower gluten, healthier oils and fewer processed ingredients. Traditional breeding takes years to bring new food varieties or quality traits to market, which has resulted in consumer food companies searching for alternative means to satisfy the evolving customer demands. Consumer demand for rapid product differentiation has created a premium food market opportunity that is one of the fastest growing segments in the food industry.

To address this large and growing demand, we are building on our industry leading scientific expertise and advanced plant breeding technologies developed over the past 16 years to produce nutrient-dense crops for use in the major foods we eat. By employing gene editing technology or using our proprietary TILLING platform, we believe we can reduce the time to market by half for novel trait ingredients, thereby providing consumer food companies a steady and reliable source of cost effective, healthy natural food options.

We are developing a suite of branded, high value, healthy ingredients in wheat. First to market will be our high fiber Resistant Starch (RS) wheat which has more dietary fiber than conventional wheat. Increased fiber consumption is well recognized as a way to improve gut health and to control excessive weight gain. Concurrently, we are developing four additional wheat traits: a reduced gluten wheat, wheat with improved protein quality, an extended shelf life wheat and a superior yielding wheat. In the traditional American diet more than 500 calories a day come from wheat products, 25 percent of the FDA's recommended daily caloric intake for women and 20 percent for men, which creates a natural market opportunity for our first two wheat products. We believe these varieties have broad application in the annual global flour market which is estimated by the FDA to be approximately $200 billion of which we believe our addressable market is $8 billion.

We also have a history of innovating in crop genetics to improve farmer productivity through more robust crop varieties, creating crop traits designed to counteract the detrimental impact of environmental stresses on harvest yields. Traditional genetic modification (GM) trait development has concentrated on crops where the combination of large acreage and high input costs (such as pest and weed control chemical costs) create significant economic value for herbicide or insecticidal traits. However, far more deleterious to crop yields are abiotic stresses, such as drought, heat, nutrient deficiency, water scarcity, and soil salinity. Mitigation of these abiotic stresses remain largely unpenetrated by the GM seed industry today. For example, industry estimates indicate greater than 80 percent of wheat yield loss and 65 percent of corn yield loss globally are lost due to abiotic factors. These stresses are prevalent in most agricultural environments with varying degrees of severity and often have material consequences on crop production, quality, and farmer incomes.

We devoted much of our early research to building a comprehensive array of abiotic stress traits. Furthermore, through out-licensing arrangements with commercialization partners, many of our traits have been bred into several global crops, including rice, wheat, and soybeans, and we have demonstrated significant yield improvements in multiple years of field testing. However, due to the global variability in acceptance of GM traits and in regulatory systems, the commercial timing and ultimate value of these innovations is difficult to predict. Regardless of the timing and degree of commercial success of our historical transgenic traits, the technical achievements they represent has established the company as a world-class plant transformation organization.

Our commercial strategy is to migrate forward in the ag-food supply chain from the farmer and seed company to the consumer food company. Due to our early stage focus on the development of abiotic stress traits, we have historically been commercially aligned with farmers and seed companies. However, by also establishing commercial relationships with consumer food companies and developing brand awareness of our high value premium ingredients, we expect to be better positioned to garner a greater share of the market. Consumer food companies are looking to simplify their food ingredient formulations and consumers are demanding "clean labeling" in their foods, paying more for foods having fewer artificial ingredients and more natural, recognizable and healthy ingredients. In 2015, the Food Business News cited ninety-one per cent of U.S. consumers believe food and beverage options with recognizable ingredients are healthier. Because we engineer nutrient density directly into staple grains and oils, we provide the mechanism for food formulation simplification naturally, cost effectively and in a time-frame to meet evolving consumer demands.

This forward migration in the ag-food supply chain will require we build additional organizational capabilities and industry expertise. For instance, we have and continue to expand our in-house commercial grain production and logistics resources for greater scale capacity to bring our identity preserved products to market. We are also continuing to develop product branding strategies to build customer brand recognition and loyalty.

Arcadia Specialty Genomics™

In February 2019, we announced the establishment of Arcadia Specialty Genomics™ ("ASG") a new strategic business unit dedicated to developing and commercializing genetic improvements targeting plant content, quality, climate resiliency and overall yield in cannabis, a new crop for the company. ASG intends to conduct its business in only federal and state markets in which its activities are legal.

The recent passage of the U.S. Agriculture Improvement Act of 2018 – also known as the Farm Bill – confirmed the federal legalization of hemp, the term given to non-psychoactive cannabis containing less than 0.3% tetrahydrocannabinol (THC). It also included provisions for legalizing on a federal level hemp's cultivation, transport and sale for the first time in more than 75 years. Hemp, previously considered a Schedule 1 drug and banned as an agricultural crop, lacks substantive plant biology research and suffers from suboptimal genetics, highly fragmented germplasm and rampant inconsistencies. As with our wheat and soybean products, we plan to create hemp-based solutions that allow farmers to be more productive and enable consumer packaged goods companies to differentiate their brands in the marketplace. In the near term, our focus will be on acquiring federal and state licensure in key geographies to launch our research and pilot programs, for which we expect to begin operations in early 2019. In parallel, we are evaluating key partnerships to extend our capabilities vertically to maximize the value creation potential of our innovations.

The Hemp Business Journal estimates the hemp CBD market – the primary non-psychoactive compound in cannabis – totaled $190 million in 2018. By 2022, the Brightfield Group, a cannabis and CBD market research firm, projects sales to reach $22 billion.

Our Strengths

We believe we are well positioned among our peers to capitalize on the need to increase the efficiency, quality and speed of innovation in agricultural product differentiation to meet the demand for healthier food choices. Our combination of technological innovation, assets and experience is why we believe we are uniquely positioned to best meet this challenge by improving crop yields to enhancing crop nutrition:

- ***World-class research capabilities.*** Our in-house scientific and product development expertise coupled with our advanced Targeting Induced Local Lesions in Genomes, or TILLING, know-how have resulted in the discovery and development of several traits in our commercialization pipeline. Our TILLING platform enables us to discover and develop value-added traits that are considered non-GM. This platform leverages high-throughput screening of induced genetic diversity in plant populations in major crops. Our TILLING populations currently include wheat, rice, soybean, and canola. These populations include numerous native and induced gene function alterations, which can be exploited rapidly at low cost and with minimal regulatory requirements. While the TILLING approach is also practiced elsewhere, we believe that the combination of our history and specialized background in the technology, highly refined skills in developing and screening genetic diversity in plant populations, and proprietary TILLING process make us a leader in commercial applications of TILLING. In 2017, we obtained a license from the Broad Institute at the Massachusetts Institute of Technology (MIT) and Harvard University for research use of the CRISPR-Cas9 gene-editing technology. This new platform will enable us to accelerate the time it takes to bring new products to the market from inception.

- ***Industry leading early phase trait development.*** Since the inception of the Company we have successfully advanced, and continue to advance, several potentially high value traits from the proof of concept stage to advanced field testing. More recently, in the case of our HB4 stress tolerant soybeans we have, through our Verdeca joint venture, advanced the trait beyond from field testing in commercial germplasm and into the regulatory submission and approval phase. We have received regulatory approval in Argentina, submitted for import approval in China, FDA approval in the U.S. with submission for USDA approval and regulatory studies are in progress for submission in Europe. By licensing our traits at a later stage of development, we expect to reduce the risk and expense associated with bringing products to market.
- ***A broad intellectual property portfolio.*** As of March 1, 2019, Arcadia's patent portfolio includes 153 issued patents and 63 pending patent applications worldwide in 30 patent families, relating to our trait technologies and business methods that are either owned or exclusively controlled by us. Arcadia had 48 patents issued and has filed 53 new patent applications since January 2015. Our ability to secure exclusive patent rights to our technologies is a key strength for the Company and one that preserves our competitive position.
- ***Expert regulatory affairs capability.*** Our regulatory team has the proven experience and demonstrated capability to manage regulatory submissions and approvals, including regulatory studies, field trials, regulatory submission, regulatory approvals and commercial launch. Our ability to bring traits through the regulatory process quickly and cost-effectively is a key differentiating factor and a capability we have deployed for our own internal development efforts, as well as in collaboration with our development and commercialization partners.
- ***We have a diverse portfolio of products and partners.*** Our product portfolio consists of a wide variety of traits that are applicable to major crops in key geographic markets and address agricultural yield and product quality. The applicability of our product portfolio to these major crops provides us access to multiple large end consumer markets that we believe have demonstrated or have the potential for high growth, such as soybeans in North and South America and wheat and rice globally. We have formed partnerships with many of the leading seed companies, grain processors and health and nutrition product companies.

Our Growth Strategy

We believe there are significant opportunities to grow our business by executing the following elements of our strategy:

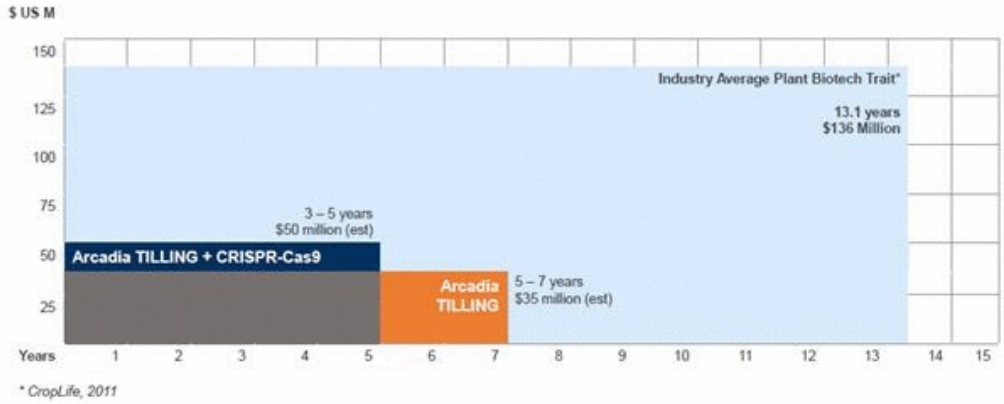
- ***Accelerate the commercialization of our health and nutrition trait portfolio.*** In 2018, we made significant advances towards commercialization of Resistant Starch GoodWheat™ achieving key technical milestones, breeding into commercial germplasm, building partnerships across the wheat value chain and meeting FDA requirement for "high in fiber" and "good source of fiber" designations. Our highest priority and primary forward investment is to accelerate the commercialization of our non-GM wheat ingredient trait portfolio, first targeting the bread, pasta and animal feed markets with our high fiber Resistance Starch and Reduced Gluten lines. We believe these products can be launched into the market over the next nine to eighteen months, and we are working with collaborators who are actively advancing the technical and commercial potential of these products.
- ***Develop and introduce novel genetics in hemp.*** Arcadia Specialty Genomics will develop novel hemp varieties possessing productivity, pest resistance and crop quality traits for license to cultivators, and for derivative products serving the nutraceutical and food industries. We intend to develop these innovations through our TILLING platform initially under the guidelines of the 2014 and 2018 farm bills in the US. Because of our proven ability to innovative traits in some of the most complex plant genomes such as wheat, we believe turning our attention to the critical needs facing the rapidly evolving cannabis industry greatly enhances our growth markets. In the near term, our focus will be on acquiring federal and state licensure in key geographies to launch our research and pilot programs, for which we expect to begin operations in early 2019. In parallel, we are evaluating key partnerships to extend our capabilities vertically to maximize the value creation potential of our innovations.

- ***Advance commercialization of GM traits in regions where regulatory processes are predictable.*** Our Verdeca joint venture continues to advance our HB4 Drought Tolerance trait in soybeans towards commercialization in the Americas, with Argentina to be the first launch country. Regulatory approvals were obtained in Argentina in 2015 and with US FDA in 2017. Regulatory submissions were made in 2016 for import approval of HB4 soybeans into China. Regulatory approval for Brazil was submitted in 2018 and import approval in the European Union will be submitted in 2019. We are encouraged by recent GM approvals in China as key indication of significant progress towards the advancement of the global GM landscape. We believe commercialization and product launch into the market may occur over the next 18 to 24 months.
- ***Actively support our licensees' product development, deregulation and commercialization efforts.*** Part of our longer-term strategy remains the potential to unlock the commercial value of our key agricultural yield traits, such as Nitrogen Use Efficiency (NUE), Water Use Efficiency (WUE), and Salt Tolerance, in key food crops like rice, wheat and sugarcane and fiber crops like cotton. We remain engaged with our partners to determine and execute optimal strategies to advance these traits through deregulation in various territories.
- ***Continue to invest in our human resources and commercialization capabilities.*** As we become more consumer facing and commercially aligned with consumer food companies, greater in-house consumer product knowledge and industry experience will be required. We will continue to invest in acquisition, development and retention of the requisite management and industry experience and production and logistics capacity to more fully participate in, and control, the route to market for our high value food ingredients. We will continue to build our commercialization expertise, refine go-to-market strategies and execute branding strategy.

Our Products and Product Development Pipeline

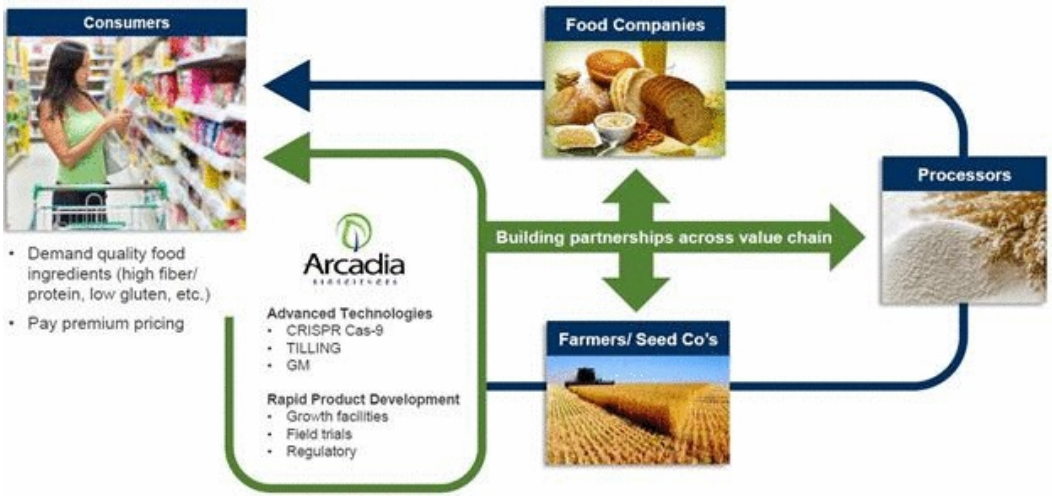
We are improving the nutrition and quality of food ingredients while improving crop productivity using advanced plant breeding and gene editing technologies and accelerating innovation through industry leading partners. Our innovations address the challenges facing our food systems as depicted below:

The development and commercialization staging of our health and nutrition ingredient traits reflect the time to market we expect based upon the remaining breeding and production requirements to achieve optimal market penetration. In 2017, we in-licensed the CRISPR-Cas9 technology, substantially augmenting the speed at which we can bring technologies discovered through our tilling technology platform to market as well as new versions of existing traits and entirely new discoveries. Our wheat portfolio development processes shorten the timeline to launch and allow broader globalization as depicted in the table below:



We believe our core competencies in plant genomics position Arcadia for unique innovations in new crops. We leverage a research and development team that has over 100 years of combined plant transformation experience across best in class technology platforms. Our competitive advantages allow for accelerated market entry.

Our health and nutrition business model creates value throughout the entire food supply chain as depicted in the graphic below:



Enhanced Quality Grains

Our GoodWheat™ brand redesigns wheat as a functional food adding value to the wheat supply chain by enabling a wider range of choices to meet consumer demands. We believe our GoodWheat™ products will allow consumers to enjoy unique health benefits in their favorite foods featuring wheat. Our GoodWheat™ product allows consumer food companies to deliver specialty products to discerning consumers. We have multiple programs aimed at developing wheat and other small grains with improved nutritional qualities. One such program generated multiple bread wheat and pasta wheat lines with very high levels of amylose, leading to increased levels of resistant starch. Resistant starch increases the total dietary fiber content of wheat and reduces its glycemic index, which are both desirable nutritional qualities that are important in the management of diabetes and healthy blood glucose levels. High fiber Resistant Starch wheat can deliver fiber and other benefits to refined white flour products and also whole grain food products. In 2016, the FDA approved the use of qualified health claims for corn-based resistant starch in the risk reduction of type-2 diabetes, thus establishing a key precedent for the health benefits associated with this fiber. According to the USDA's What We Eat in America Survey of 2015-2016, only 5% of the U.S. population meets the recommended level of dietary fiber. On average, Americans consume only 57% of the daily recommended levels. We believe improving the fiber content of wheat can deliver improved health benefits to a wide population.

A second program, in collaboration with Ardent Mills, aims at improving the flavor profile and shelf-life of whole wheat. A third program is aimed at reducing gluten in wheat and other grains. This program additionally targets improved protein quality and amino acid profile in wheat. All of these programs utilize our TILLING platform, and the resulting products are non-GM.

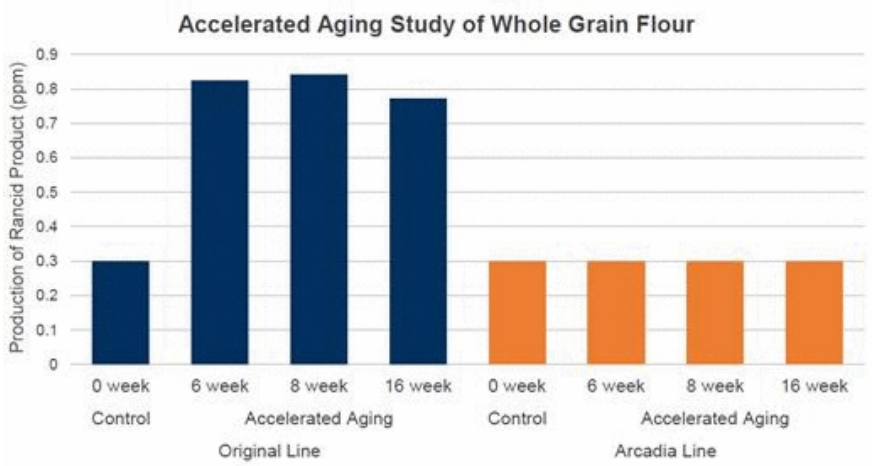
High Fiber Resistant Starch Wheat

Our high fiber Resistant Starch (RS) wheat provides a source of wheat with inherently high levels of resistant starch, increasing the total dietary fiber content of food products without the need for fiber additives from other sources. Currently, corn resistant starch is a product in two market segments: dietary fiber additives and modified starch additives. According to MarketsandMarkets, the global dietary fibers market is projected to reach $6.5 billion by 2022 and the modified starch market is projected to reach $12.4 billion in 2022. Major growth in these markets is being driven by the convenience health food sector and functional food sector. Flour from our RS wheat lines has resistant starch levels that are 12 to 20 times higher than the control wheat, and total dietary fiber, or TDF, which is more than eight times higher than the control. RS wheat flour has been tested in applications in bread, where loaf quality was comparable to bread made with conventional wheat flour, and pasta, where it had the highest consumer preference rankings in tests carried out by a major consumer products company. In 2018, we made significant advances towards commercialization of Resistance Starch GoodWheat™.

RS wheat flour is currently being tested in a range of additional bakery, ready-to-eat cereals and pasta products with industrial partners. We have many RS wheat lines that are being evaluated for optimal quality and agronomic characteristics.

Improved Shelf Life of Whole Grain Flour

The USDA recommends that "at least one serving of grains per day must be whole grain-rich" due to evidence that a diet containing whole grains provides a multitude of benefits, including lower risk of obesity, cardiovascular disease, and type-2 diabetes. Despite these health benefits, consumption of whole grain products is negatively affected by the bitter and rancid flavors and odors that accumulate in whole wheat flour after milling. Our improved stability and flavor wheat lines greatly reduced the production of rancid and bitter compounds in aged whole grain flour. Whole wheat flour from these lines is being tested further for sensory characteristics and improved shelf life stability. This new trait could help improve the shelf life and flavor profile of whole grain products, thus reducing formulation costs and increasing consumer preference and palatability for whole grains.

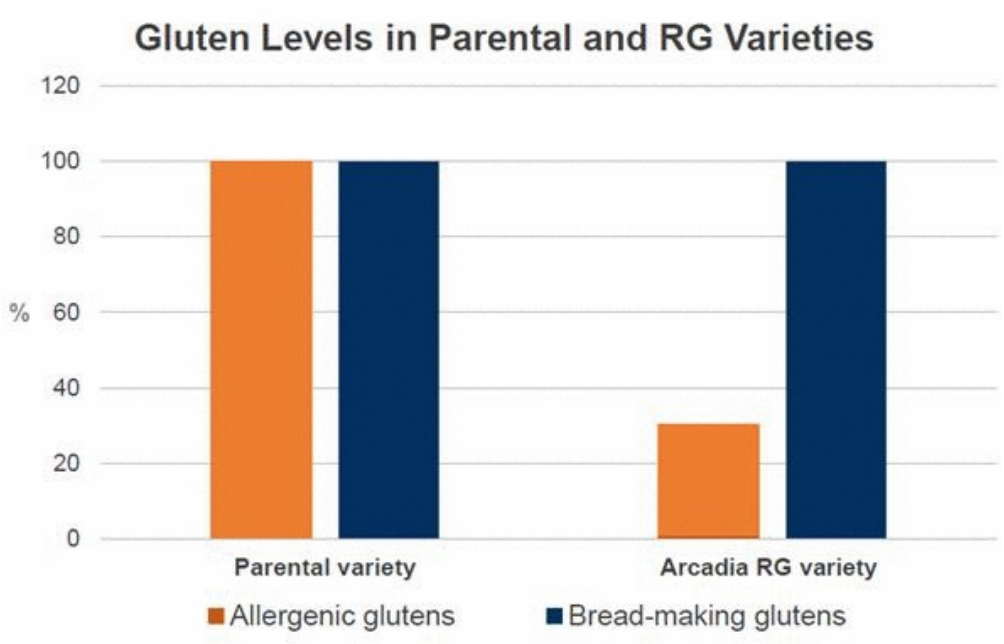


Reduced Gluten (RG) Wheat

Many consumers are interested in reducing levels of gluten in their diet. Critically, for some, this is due to having Celiac disease (CD), an autoimmune disease that impacts many people worldwide with estimates from 1% of the population in Europe to 3.5% in Mexico. Furthermore, non-celiac gluten sensitivity (NCGS) impacts an estimated additional 6% of the population. Both CD and NCGS are characterized by sensitivity to dietary gluten. The only effective treatment of CD and NCGS requires removal of gluten sources from the diet. Since required adherence to a gluten-free diet is extremely difficult to accomplish for average consumers, efforts to develop alternative approaches are needed.

Research conducted by the Connell Group in 2018 indicates there is a significant portion of consumers (26% of general population) that choose to reduce gluten levels in their diet despite not having Celiac disease.

Arcadia is developing a new wheat variety with reduced gluten levels. Our proprietary, non-GM wheat variety developed using advanced screening and plant breeding techniques have reduced allergenic glutens and increased essential amino acids such as lysine, along with all the other health benefits of high protein wheat. This new variety is beneficial for both food and feed applications. We are breeding the trait into commercial wheat varieties and working with food processors to give people a choice to enjoy higher quality wheat in the products they love while reducing gluten in their diet.



Nutritional Oils

Gamma Linolenic Acid (GLA) Oil

Under a license agreement with Abbott Laboratories, we developed a new source of vegetable oil with very high levels of gamma linolenic acid, or GLA, an omega-6 fatty acid. To our knowledge, our GLA safflower oil product has the highest concentration of GLA available in any plant oil at 65%; conventional plant oils range from 10 to 22% GLA. We sell the oil in the United States to manufacturers of dietary supplements, nutritional supplements, medical foods, dog food, and other products. GLA safflower oil is also approved in Canada as a natural health product. Our key customers include significant participants in those markets, such as GNC, Lindora Nutrition, JumpStart MD and others.

GLA has multiple clinically-demonstrated nutritional and medical benefits, including anti-inflammatory effects, improving skin conditions such as atopic dermatitis and healthy weight management. Multiple parties have expressed commercial interest in incorporating an enhanced GLA oil into their foods, dietary supplements, or medical products where conventional sources of GLA are not sufficiently concentrated to deliver amounts that are cost- and performance-effective.

Against a commercial target of 40% GLA concentration, we developed, deregulated and commercialized GLA safflower oil containing up to 75% GLA concentration in fewer than six years. This is significantly shorter timeline than the 13 years it takes, on average, to commercialize an agricultural biotechnology product, according to Phillips McDougall in 2018. We produce GLA safflower oil by contracting with farmers in Idaho and process the seed under contract with a manufacturer in California to make refined oil. We sell GLA safflower oil under the brand name, SONOVA, with multiple concentrations and formulations.

In January 2017 we received notification from the FDA that our GRAS petition (generally recognized as safe) for the use of SONOVA GLA in medical foods and nutritional beverages had been accepted, which means that we can now market and sell this product in a new market segment. In August 2017, the FDA published in the Federal Register a food additive regulation for the use of SONOVA GLA in dog food. The FDA published a similar regulation for cat food in February 2019. These approvals and authorizations are generating additional revenue opportunities for our GLA business.

Agriculture Productivity Traits, the Yield and Stress Pipeline

Arcadia is a recognized leader in the area of yield and abiotic stress trait development and our research and development successes are built on the premise that mitigating the impact of environmental stresses, whether chronic or transient, can generate meaningful yield gains in the most important crops in the world. Although our forward development programs are non-GM based, we have historically out-licensed a number of high-performing traits developed using transgenic development platforms to commercialization partners who have been pursuing deregulation in their licensed territories for the last several years. We believe our yield and stress pipeline holds promise, as evidenced by our internal data and data generated by our partners in rice, wheat, soy, corn and cotton varieties. However, due to the continued uncertainty of broad acceptance of GM traits, the commercial timing and value of these innovations is unclear.

Nitrogen Use Efficiency (NUE)

Our NUE technology enables plants to utilize nitrogen fertilizer much more efficiently than conventional plants. This allows crops to achieve significantly higher yields under normally applied levels of nitrogen fertilizer, or to achieve the same yields as conventional crops while using 30 to 50% less nitrogen fertilizer.

Field trial data to date in multiple major commodity crops has shown yield improvements greater than 10% attributable to our NUE trait. Additionally, NUE rice tests conducted by independent entities in multiple countries over multiple years have demonstrated that NUE rice lines produced significantly higher grain yield than controls at various nitrogen fertilizer rates. In the paddy low-land production environment, NUE rice lines showed an increase in grain yield of 29.5% at full nitrogen application rates when compared to the parental line. In the rainfed up-land production environment, the NUE rice lines demonstrated 33.8% grain increase at 50% nitrogen application rate.

Water Use Efficiency and Drought Tolerance

Our Water Use Efficiency (WUE) trait enables plants to better tolerate two distinct types of stress: reduced or inconsistent water availability, and severe drought. The WUE trait has been demonstrated to improve crop yield under conditions of episodic water stress and to help crops recover from severe drought conditions. A related but distinct trait, Drought Tolerance, helps plants maintain yields under conditions of prolonged water stress.

Our WUE trait technology was jointly discovered by researchers at the University of California, Davis and Technion—Israel Institute of Technology. We hold an exclusive, global license to the technology, with sublicense rights, for use in all crops. Greenhouse and field trials of our WUE traits have been completed in agronomic crops such as rice, wheat, cotton, peanuts and alfalfa. Our collaborators are working with our traits in potato, sugarcane, and cotton.

Our Drought Tolerance (DT) technology in soybeans was discovered by researchers at the National Scientific and Technical Research Council (Argentina), and further developed by Bioceres, S.A. Verdeca, our joint venture with Bioceres, Inc., who holds exclusive global rights and is developing and commercializing this technology in soybeans.

Our Drought Tolerance technology is most advanced in soybeans. Multiple seasons of field trials in test germplasm in both North and South America have shown better or equal yield performance of our HB4 drought tolerant trait relative to controls. We expect the optimum performance of this trait will be in the drought stressed regions of South America. Verdeca and seed company licensees are introgressing the trait into pre-commercial germplasm in Argentina to address this market. The Early Food Safety Evaluation process was completed in 2015 by the U.S. Food and Drug Administration (FDA) for the plant protein responsible for our Drought Tolerance trait. The trait has full approval for food safety and international commerce in Argentina (2015) and is pending approval in China. Regulatory approval application was submitted in 2016 to the FDA and the FDA completed its review in August 2017 allowing for food and feed consumption in the US. USDA request for a Determination of Nonregulated Status was submitted in 2017 and is currently pending approval. Additionally, regulatory approval applications have been submitted in Uruguay and are pending final approval. Regulatory submissions were made in 2016 for import approval of our Drought Tolerant HB4 soybeans into China. Regulatory approval for Brazil was submitted in 2018 and import approval in the European Union will be submitted in 2019.

Salinity Tolerance

Our Salinity Tolerance trait allows plants to maintain yields under conditions of elevated salinity and is applicable to a wide range of crops, including wheat, rice, soybean, and cotton.

Our most advanced Salinity Tolerance trait technology is based on technology from the University of Toronto, the University of California, Davis, and the National Institute of Agrobiological Sciences (Japan), all of which have granted us exclusive licenses for all crops. In addition, we are conducting research on additional salinity tolerance genes under a funded research agreement with the United States Agency for International Development, or USAID.

Crops with tolerance to soil and water salinity are in various phases of development with our primary licensee and partner for the Salinity Tolerance trait technology. Our partner previously tested the most promising rice lines with our trait in a field in which controlled amounts of salt were applied to the replicated plots. In 2015, a field trial was executed on naturally high saline farmlands in India, where grain yields typically are very low, and we saw results similar to those in prior trials. Our partner has developed wheat lines that show significant salinity tolerance under greenhouse conditions, with some lines outperforming the controls by more than 30%, and additional wheat lines are in development to expand the scope of our partner's first greenhouse evaluations.

Wheat Yield

Our non-transgenic wheat yield program, initially supported by USDA, aims to increase yield in wheat using TILLING, a non-GM reverse genetics tool, to identify novel alleles of candidate wheat yield genes in tetraploid and hexaploid wheat. These alleles are being evaluated for the ability to alter wheat architecture and improve yield in the field. As a non-GM technology, products from TILLING can rapidly advance to commercialization and do not face market or regulatory restrictions. According to the USDA's estimate in 2017/2018, with a conservative 5% increase in yield, the yearly value creation to the U.S. farmer is estimated at over $30 per hectare. In addition, the value of higher yielding wheat varieties to a seed company arising from this research in the U.S. alone is more than $40 million annually. By incorporating favorable alleles of plant architecture genes into a commercial wheat breeding program, we believe we can make a significant contribution to improving yield in this vital food crop.

Technology Evaluation

Our technology program teams include scientists who are leaders in their respective fields along with supply chain logistics, quality control and assurance and commercial production and development. These teams contribute to the initial evaluation of new opportunities and are responsible for development of technologies brought onboard or developed in-house. Each of our technology programs involves multiple gene, trait and crop targets, and our process focuses on rapid development of the most promising combinations. In the development of any particular trait, we carry out a series of steps including the direct evaluation of target gene function and the specific evaluation of results in key representative crop species that bring value to commercial product applications. While common core scientific services are provided by functional groups, our technology program team manages overall progress and remains directly involved throughout the development cycle, internally as well as externally with our collaborators.

Product Development Platforms

Targeting Induced Local Lesions in Genomes (TILLING)—Non-GM Traits. Our advanced breeding TILLING platform enables us to develop value-added crops without the use of GM methods. The TILLING platform is managed by a dedicated team of scientists able to apply TILLING to multiple crops with complex genomes. TILLING technology utilizes specialized laboratory equipment to carry out high-throughput allele screening of DNA samples from genetic diversity populations created in major crops. Our populations include wheat, rice, soybean, and canola. These populations include numerous native and induced gene function alterations, which can be discovered and evaluated rapidly at low cost and with minimal regulatory requirements. We believe the combination of our background in the technology as the first to apply TILLING to crop plants such as wheat and tomato, and our highly refined skills in developing and screening genetic diversity in plant populations makes us a leader in commercial applications of TILLING.

Transformation—GM Traits. For projects involving GM traits, the genetic construct for insertion into plants is designed and built by our relevant program team, and then the gene transfer step is accomplished by our plant transformation functional group. This group has developed a complete physical and methodological infrastructure at our laboratory facility in Davis, California to efficiently transfer genetic materials into key crop species. Our team has demonstrated transformation capabilities in all primary and some secondary agricultural crops, including rice (japonica, indica and NERICA types), wheat, corn, canola, safflower, barley, sorghum, alfalfa, tomato, potato, tobacco and grapes.

Genome Editing. Our genome editing pipeline includes a cross disciplinary group of experienced molecular biologists and plant transformation experts with demonstrated capabilities in using both biological and physical methods of plant transformation. Our expertise in both transformation and TILLING in the application of genome editing has helped to accelerate new product development.

In 2017, we obtained a license for research purposes for CRISPR- Cas9 from the Broad Institute of MIT and Harvard. We believe this is the leading gene editing technology and using this technology will accelerate product development.

Controlled Growth Operations. Our controlled growth operations group manages our growth chamber facilities, where plants are grown under precisely controlled conditions, and our greenhouse facility, consisting of approximately 26,000 square feet of high-quality greenhouse space, which are both at our headquarters in Davis, California. The controlled growth operations group uses these facilities to manage plant experiments and grow-outs under rigorously controlled conditions. They also carry out the initial seed increases and first stages of plant breeding for some projects. For certain projects, such as those relating to oil quality and high fiber Resistant Starch wheat, this group also manages crop pre-breeding programs to develop plant varieties for the production of commercial products.

Research, Field Trials, Breeder & Foundation Seed Production. Our trait evaluation and development group is based in Davis, California and conducts remote field operations in American Falls, Idaho; Yuma, Arizona; Brawley, California and multiple locations in Montana, North Dakota and Washington. The trait evaluation and development group have extensive field and specialized statistical analytical capabilities that we deploy to support field trial execution and data analysis internally and with our collaborators. Late-stage regional and agronomic trials are intended to develop extensive data on a limited number of potential commercial plant varieties and develop the best crop management practices suited for these commercial products. Similarly, regulatory trials develop data for use in submissions for regulatory review and may involve plant varieties developed by our collaborators or our own oil quality and grain quality programs.

Commercial Seed, Grain and Oil Production. The commercial development group is based in Davis, California. The group conducts grower field trials and manages the commercial seed, grain and oil production throughout the United States working through seed production specialists and growers and elsewhere globally with our collaborators and joint venture partners. Grower field evaluations are designed to test new commercial seed varieties for yield and agronomic performance and as well as characterizing performance of oil and grain quality attributes.

Regulatory Data Generation. Our Analytical Services and Regulatory Science group is located in Davis, California and provides automated DNA preparations, genomic blot analyses, lipid profiling, metabolomics and protein purification services and develops data for use in product selection and validation, certification of SONOVA, GoodWheat™ and other product specifications, and regulatory submissions. These data support regulatory submissions and provide core trait regulatory packages to our collaborators for use in their crop-specific regulatory applications.

Biological Materials Inventory and Tracking. Our proprietary Pedigree and Inventory Management System, or PIMS, tracks the genetic, phenotypic and location information for all our plant materials. PIMS encompasses genetic elements such as genes and promoters, GM seeds and plant material received by us, as well as seeds and plants developed by us and used in trait development. The performance of our plant materials is recorded through a variety of laboratory and field observations, and the data are stored within PIMS. The location of all plant materials is tracked throughout the plant life cycle. This includes specific seeds planted within a specific plot of a specific field trial, harvest, seed storage location and use by, or distribution of plant material to, our collaborators or elsewhere. PIMS interfaces with our Biotechnology Quality Management System, or BQMS, to manage all movement and release of regulated GM plant materials. This ensures all our plant materials are accounted for, tracked and inventoried, which enables us to maintain control over and documentation of all plant materials.

Regulatory Compliance and Stewardship

Our regulatory management team provides regulatory services for all our product development programs, as well as joint ventures and selected collaborations. These services include establishing standard operating procedures and best practices, completing regulatory permits and monitoring regulatory and stewardship compliance for all products at all stages. Our regulatory team includes key employees who are directly responsible for leading all global regulatory agency interactions and providing tactical and strategic regulatory direction. Our team collectively has more than 30 years of direct involvement in the development and approvals of GM crops. The key member of our regulatory team was responsible for completing the first FDA and USDA deregulation of a GM whole food. The interactions and processes associated with these first USDA and FDA processes established benchmarks for the regulation of GM products that remain applicable today.

Our regulatory management and compliance activities encompass three broad categories: deregulation, stewardship, and authorization. In the United States, these activities are regulated by various government agencies, including the USDA, the FDA and the U.S. Environmental Protection Agency (EPA). Our regulatory team has completed significant regulatory activities (new dietary ingredient review, food additive regulation, GRAS (generally recognized a safe) notice and GM food consultation) with the FDA Division of Dietary Supplement Programs, with the FDA Center for Food Safety and Applied Nutrition, with the FDA Center for Veterinary Medicine with the Health Canada Natural Health Products Directorate and the Canadian Food Inspection Agency.

Deregulation

Our business is subject to regulations related to agriculture, food and the environment. Plant products produced using GM technology are subject to laws and regulations in countries where the plants are grown and in countries where the GM plant-derived food and feed are consumed by humans or animals. Commodity products utilizing our GM traits may require approvals in multiple countries prior to commercialization.

U.S. Regulatory Agencies:

U.S. Department of Agriculture. We must obtain USDA authorizations and permits in order to conduct the field releases of GM regulated materials that are necessary to advance the development of GM crops. Obtaining such authorizations and permits is generally routine and delays impacting the planned movement or release of GM material are uncommon. The USDA provides detailed regulations and guidance for obtaining a *"Determination of Deregulated Status,"* which authorizes the commercial and uncontained growing of GM plants. For regulated GM plants, the USDA requires that a company petition the agency to demonstrate that the product is unlikely to pose a risk. Based on the information provided, the USDA prepares an Environmental Assessment (EA) and/or an Environmental Impact Statement (EIS) in order to make its determination. These procedures afford the public an opportunity to submit written comments on the draft EA or EIS for consideration by the USDA before the final version of the EA or EIS is published. For any GM plant product, there may be delays or requests for additional information based on the USDA's review or the public comments. As of March 2019, USDA has issued 126 Determinations of Nonregulated Status. Submissions received by the USDA from all applicants prior to 2011 averaged more than 2 years for approval. Since then, the USDA has significantly shortened the time to approval, averaging 1 year in 2017.

U.S. Food and Drug Administration. The FDA is responsible for food safety under the Federal Food, Drug and Cosmetic Act. The FDA recommended in its 1992 *Statement of Policy: Foods Derived from New Plant Varieties* that developers of GM plant products consult with the agency about the safety of GM products under development. In 1996, the FDA provided additional guidance to the industry on procedures for these consultations. These procedures require a developer intending to commercialize a food or feed product derived from a GM plant to first meet with the agency to identify and discuss relevant safety, nutritional and other regulatory issues regarding the product. Subsequently, the developer submits to the FDA a scientific and regulatory assessment supporting proposed product safety. The FDA evaluates the submission and engages with the developer to resolve any questions, requests for additional data or other informational requirements. Once the FDA has determined that all requirements have been satisfied, the FDA concludes the consultation process by issuing a letter to the developer acknowledging completion of the consultation process with the addition of the product to the list of completed consultations on the FDA website. The completed consultation acknowledges product safety for use as food and feed. To date, over 150 GM products have completed this process with the FDA. This process may have delays if the FDA requires additional data and information for its consultation and to resolve any questions the FDA may have. The FDA completed 21 consultations from 2015 to 2017, with consultation time periods in 2017 ranging from 2 to 15 months and averaging just over one year from first submission to conclusion.

Environmental Protection Agency. Certain products may also be regulated by the EPA, including plants that contain a plant-incorporated protectant, such as a pesticides or herbicide, or plants engineered to be treated with industrial chemicals.

International Deregulation:

When products from GM crops are expected to be exported from the United States, commercialization of such crops in the United States will require approvals in those countries into which the crops or derivative products, such as grain, oil or meal, will be exported. The laws and regulations for GM plant products are well defined in most commercially significant countries, including Australia, South American countries, India, China, several African countries and the European Union. Typically, our collaborators are responsible for obtaining all regulatory permits and approvals relevant to product development and commercialization in their licensed countries and for generating crop and transformation event-specific data required by their countries of interest. We provide basic safety data on trait expression products in accordance with generally accepted standards. In addition, we may serve as a regulatory consultant and participate in the design of regulatory protocols, data generation and development of detailed regulatory submissions. In certain countries, we may develop strategic business relationships or employ independent consultants with country-specific knowledge and expertise to support and obtain required approvals.

Stewardship

Stewardship, or the careful and responsible management of assets, forms the foundation of our regulatory compliance programs associated with GM plants. Our stewardship framework for GM plants is defined by government regulations and related internal policies and practices. In previous years, Arcadia's Biotechnology Quality Management System (now identified as ABQMS) was developed by us and then audited/certified by the USDA Animal and Plant Health Inspection Service, Biotechnology Regulatory Service (APHIS BRS). Recently, USDA updated its BQMS program renaming it the Biotechnology Quality Management Support Program, discontinuing the mandatory auditing/certification standard.

Our ABQMS program was developed to address all conditions required under USDA authority to ensure containment of regulated plant material. The ABQMS includes standard operating procedures, or SOPs, recording and reporting forms, instructions for managing all compliance related activities, and training requirements for all individuals handling GM plant materials. SOPs are highly detailed and consider all elements of each relevant activity or process. Each field trial site is accompanied by a Field Compliance Guide and Record (GUIDE) containing multiple SOPs and associated forms for each activity. For example, a GM wheat trial requires 19 SOPs and associated verification forms. A GUIDE is completed for each regulated field trial and serves as a completed record to support compliance with government regulations. Example copies of the GUIDE have been provided to our collaborators for use in other countries where they conduct GM field trials.

Since our ABQMS program was first recognized by the USDA in 2011, each annual independent audit conducted by USDA until discontinuation of their audit program confirmed that our program was functioning as intended. Our ABQMS manager has attended USDA BQMS training programs at the request of the USDA to assist in training personnel at other companies and organizations and to share our experience and the SOPs that form the basis of our program.

Compliance with the specific parameters of regulatory requirements is only one element of stewardship. Additional activities within each functional group throughout the company are integral to the overall stewardship program. Each of our employees is trained on, and must comply with, relevant stewardship guidelines as defined and described in our ABQMS.

Authorization

The USDA APHIS Biotechnology Regulatory Service (BRS) has legal and regulatory authority over the movement and release of GM plants and seeds. "Movement" includes movement of regulated GM plant material between states and the importation of regulated GM plant material into the United States. "Release" includes field trials of any size and any other use of regulated GM plant material outside of contained greenhouses.

We have obtained more than 200 authorizations from the BRS for the movement, importation or release of GM plants under development. General and specific conditions to maintain containment during all activities associated with the movement or release are a requirement of each authorization. These conditions are defined, applied and recorded in the GUIDE following our ABQMS program.

Intellectual Property

We rely on patents and other proprietary right protections, including trade secrets and contractual protection of our proprietary know-how and confidential information, to preserve our competitive position.

As of December 31, 2018, and in summary, we owned or exclusively controlled 141 issued patents and 61 pending patent applications worldwide. These totals reflect the following: (i) with respect to the U.S. territory, we owned 11 and exclusively in-licensed 16 U.S. issued patents, and we owned 11 U.S. patent applications relating to our trait technologies and business methods; and (ii) in connection with foreign territories, we owned 14 and exclusively in-licensed 100 foreign issued patents, and owned 45 and exclusively in-licensed five pending foreign patent applications. With respect to all of the foregoing patent assets, our exclusive licenses afford us control over the prosecution and maintenance of the licensed patents and patent applications. These numbers do not include in-licensed patents for which we either do not have exclusive rights (such as certain enabling technology licenses), or for which we have exclusive rights only in a limited field of use or do not control prosecution and maintenance of the licensed patents.

As of December 31, 2018, we had eight registered trademarks in the United States and also eight registered trademarks in various other countries.

We also have entered into in-license agreements enabling the use and commercialization of our traits, including NUE, WUE and Salinity Tolerance, and certain products that we have commercialized or are under development, including GLA safflower oil and ARA safflower oil. Under these licensing arrangements, we are obligated to pay royalty fees on sublicense revenue and net product sales ranging between low single digit percentages and percentages in the mid-teens, subject in certain cases to aggregate dollar caps. The exclusivity and royalty provisions of these agreements are generally tied to the expiration of underlying patents. After the termination of these provisions, we and our collaborators may continue to produce and sell products utilizing the technology under the expired patents. While third parties thereafter may develop products using the technology under the expired patents, in many cases, we have incremental patent rights covering our most important technologies, which we believe mitigate the impact of the expiration of these patents, or the related exclusivity provisions, on our business. We also have numerous in-licenses relating to enabling technologies utilized in our development programs, such as transformation methods (e.g., Japan Tobacco, DuPont Pioneer), genome editing tools (e.g., Broad Institute), promoters (e.g., Corteva Agriscience formerly known as Dow AgroSciences, Louisiana State University) and selectable marker technologies (e.g., Bayer). These in-licenses are non-exclusive and include some combination of upfront and annual license fees, milestone fees, and commercial royalty obligations consisting of low percentages or a low dollar per acre fee.

Below is a summary of our in-license agreements that we believe are most significant for our more advanced product development programs.

University of Alberta. We hold an exclusive license from the University of Alberta to the patent portfolio that form the basis of our NUE program, which began in 2002. In exchange for an upfront license fee and royalties on sublicense revenues and net product sales (which are capped at an aggregate amount in the mid-seven figures), and subject to the University's right to perform academic research using the technology, we exclusively control all research, development, commercialization, and sublicensing of the patented technology globally for all crops.

The John Sperling Foundation, formerly The John Sperling Revocable Trust. In conjunction with a sponsored research and development agreement entered into in 2003, we obtained an exclusive license from Blue Horse Labs, an affiliate entity of our majority stockholder, Moral Compass Corporation and whose rights were later assigned to the John Sperling Revocable Trust and subsequently The John Sperling Foundation ("JSF"), for technology related to several of our development programs. Under the sponsored research and development agreement, The JSF has an ownership right in patents covering technology that was developed using Blue Horse Labs funds, including certain NUE and GLA safflower patents. In the corresponding license agreement, in exchange for a single-digit royalty on net revenues and management of all aspects of the patent portfolio, we exclusively control all research, development, commercialization, and sublicensing of the patented technology globally for all crops.

University of California, Davis. Our WUE technology was developed under an exclusive option agreement with the University of California, Davis, pursuant to which we exercised our right to secure an exclusive license in 2010. We also hold an exclusive license from the University of California, Davis, to the patent portfolio that forms the basis, along with the license from the University of Toronto described below, of our Salinity Tolerance program. In exchange for an upfront license fee, license maintenance fees, and royalties on sublicense revenues and net product sales, we exclusively control all for-profit research, development, commercialization, and sublicensing of the patented technology globally for all crops.

University of Toronto. We hold an exclusive license from University of Toronto to the patent portfolio that forms the basis, along with the license from the University of California, Davis as described above, of our Salinity Tolerance program. In exchange for an upfront license fee, a royalty on revenues, and payment of all costs associated with the patent portfolio, and subject to the University's right to use the technology for research and teaching purposes, we exclusively control all for-profit research, development, commercialization and sublicensing of the patented technology globally for all crops.

Key Collaborations

Since our founding in 2002, we have established numerous trait collaborations and have developed close relationships with industry-leading seed and consumer product companies. Our partnerships with global strategic seed and consumer product players enable us to further participate in the development and commercialization of innovative products that promise to play significant roles in improving global crop efficiency and enhancing human health. We believe that the expertise and opportunities created by these collaborations represent important assets to our business. Below is a summary of selected collaborative partnerships that we view as key to the achievement of our near-term and mid-term business objectives.

Mahyco

We have multiple agreements with Mahyco covering numerous programs, using our most advanced traits in multiple major crops, and have been working with Mahyco as a key partner since 2007. Our agreements with Mahyco in NUE rice and salt tolerant rice are in advanced stages of development.

Under our various agreements relating to our NUE, WUE, and Salinity Tolerance traits, Mahyco has exclusive research and commercial rights in all licensed geographies and must timely meet certain diligence milestones in order to maintain their exclusivity. Each of our agreements with Mahyco includes an upfront technology access fee, technical and regulatory milestone fees, and, once products utilizing our traits are commercialized, we are entitled to receive a portion of the commercial value of seeds sold by Mahyco incorporating our traits. Rights to new intellectual property developed under an agreement are owned by the inventing party or parties.

In December 2017, we reached agreement with Mahyco for the return of licensed geographies and crops for certain WUE, NUE & Salinity Tolerance traits where Mahyco either lacks the resources or expertise to effectively progress trait deregulation and commercialization. In addition, for other geographies where Mahyco has progressed trait development but does not possess the familiarity with, or influence on, the regulatory environment to affect deregulation, we are currently evaluating the feasibility of redeploying these technologies to a new licensee. As of December 31, 2018, the parties have not completed, modified or added new license agreements, which are targeted for completion in early 2019.

Bioceres

In 2012, we partnered with Bioceres, an Argentina-based technology company, to form Verdeca LLC, a U.S.-based joint venture company engaged in the development and deregulation of soybean traits, of which we own 50%. We selected Bioceres as our partner in soybeans—the world's fourth largest crop by area grown and the fourth most valuable at —due to their desirable trait portfolio, their presence in key South American markets, and the significant presence of large soybean growers in their ownership structure.

Our joint venture agreement provides for each of the joint venture partners to license its trait technologies to Verdeca for use in soybeans, with product development and regulatory efforts equitably divided and managed by us and Bioceres under stand-alone service agreements that are executed annually. The first product in the Verdeca pipeline is a drought and abiotic stress tolerance trait that has already completed extensive validation trials and is now in the regulatory phase of development. This trait has been demonstrated to confer a yield advantage over conventional soybeans grown under the same suboptimal conditions. In April 2015, Verdeca received the first regulatory approval of its stress tolerance trait in soybeans in Argentina. This is the world's first regulatory approval of an abiotic stress tolerance trait in soybeans, which we believe is an important initial step in pursuing additional regulatory approvals that Verdeca intends to seek in multiple geographies globally. Verdeca has successfully negotiated favorable market access in South America through established players and is working on adding market channel partners in the United States, Brazil, Uruguay, Paraguay, South Africa and China.

In addition to those agreements, we also have negotiated exclusive access to Bioceres' drought and abiotic stress tolerance trait for use globally, outside of South America, in wheat. Our agreement with Bioceres provides for sharing of trait value once a product is commercialized.

Ardent Mills

In November 2018, we announced our collaboration with Ardent Mills, LLC to develop and commercialize wheat innovations. Ardent Mills, LLC is North America's leading flour-milling and ingredient company. Our first project focuses on extending the shelf life and improving the flavor of whole wheat products.

By using patented Arcadia trait technology, the storage life of whole wheat flour can be extended by slowing the enzymatic processes that reduce shelf life. Because milled flour from wheat carrying Arcadia's trait technology oxidizes more slowly, it also minimizes the bitterness associated with most whole wheat products. This trait is expected to help improve the taste of whole wheat products and help reduce waste.

The extended shelf life wheat trait was developed using our proprietary non-GM wheat genetic diversity TILLING library, an extensive and exclusive resource of trait lines with high-density variations in genetic composition and gene function. Because it is non-GM, the trait has wide application potential across both conventional and organic farming practices. We recently received a U.S. patent for the technology which extends the storage life of whole wheat flour by minimizing oxidation, the latest in our portfolio of wheat trait improvements. We will continue further collaboration with Ardent Mills, LLC and university partners to bring this trait to commercialization in products.

Corteva Agriscience

In August 2017, we entered into a new strategic collaboration with Corteva AgriScience to jointly develop and commercialize a breakthrough improved wheat quality trait in North America. The collaboration leverages our TILLING platform with Corteva Agriscience's enabling technology platforms, high-quality elite germplasm and global commercial channels.

Under the collaboration, the companies will further develop and commercialize an improved wheat quality trait, which has completed initial field trials and is advancing to next-stage field trials. Corteva AgriScience will introgress Arcadia's trait into its proprietary elite germplasm lines and manage all aspects related to the trait commercialization. Certain development costs will be co-funded, and we will share in the commercial value resulting from products produced.

Scientific Advisory Board

We maintain a scientific advisory board consisting of the members identified below. Our scientific advisory board meets on a quarterly basis and is comprised of industry and academic experts that have extensive experience in the analysis, research and development, and commercialization of biotech plants, including experience relating to discovery, transformation, and field trials. We consult with our scientific advisory board on a variety of matters pertaining to our current and future pipeline of products in development, including, for example, trait selection and development, transformation and TILLING methodologies, field trials, regulatory matters, and intellectual property evaluation.

We currently have a scientific advisory board that consists of three members as follows:

Luca Comai, Ph.D. is a professor of plant biology at the University of California, Davis Genome Center. Dr. Comai's lab is involved in two areas pertinent to breeding. In the first, they study genome regulation, hybridization, and heterosis responses in chromosome copy number variants and interspecific hybridization. In the second, they develop methods and resources for functional genomic discovery, including TILLING, which allows targeted inactivation of genes in crop plants. The research combines plant genetics and genomics with the use of next-generation sequencing, bioinformatics and genome editing to identify genes responsible for traits of interest as well as to discover and use natural and induced variation. Dr. Comai is known for his pioneering work creating glyphosate tolerant crops, and as a founding scientist in Calgene Pacific, Targeted Growth, Inc. and Tilligen. He is a Fellow of the American Association for the Advancement of Science.

Todd Abraham, Ph.D is the former senior vice president of research and nutrition for Mondelēz International (formally Kraft Foods). He was responsible for worldwide technology development and strategy, long term cross category research programs, analytical sciences, open innovation, consumer sciences and knowledge management across the enterprise, as well as the Reading Scientific Services LTD business in Reading, UK. Before joining to Mondelēz International as senior vice president, product development, Nabisco Foods Company, he held previous leadership positions in marketing, general management and R&D at Pillsbury and Procter and Gamble with both North American and international experience. Dr. Abraham completed his Sc.B. in chemistry at Brown University in Providence, RI. He received his Ph.D. in chemistry from the University of Pennsylvania and his M.B.A. in strategic planning from The Wharton School.

Scott Haley, Ph.D. is a professor and wheat breeder in the Soil and Crop Sciences Department at Colorado State University (CSU). Since 1999 he has led the Wheat Breeding and Genetics Program focused on developing improved hard red and hard white winter wheat varieties for eastern Colorado and the High Plains region. Among Dr. Haley's accomplishments are the development of 40 improved wheat varieties and 2 wheat germplasm lines. In addition to research, Dr. Haley is also active in teaching, student advising, and outreach. Following completion of a B.S. degree in botany at Washington State University, Dr. Haley served with the Peace Corps in West Africa prior to joining CSU as a graduate student in wheat breeding. He then completed a post-doctoral appointment in bean breeding at Michigan State University and served 5.5 years as a wheat breeder at South Dakota State University.

Competition

The markets for seed traits and agricultural biotechnology products are highly competitive, and we face significant direct and indirect competition in several aspects of our business. Competition for improving plant genetics comes from conventional and advanced plant breeding techniques, as well as from the development of advanced biotechnology traits. Other potentially competitive sources of improvement in crop yields include improvements in crop protection chemicals, fertilizer formulations, farm mechanization, other biotechnology, and information management. Programs to improve genetics and chemistry are generally concentrated within a relatively small number of large companies, while non-genetic approaches are underway with broader set of companies.

In general, we believe that our competitors generally fall into the following categories:

- *Specialty health and nutrition ingredient companies*: In response to the growing consumer demand for healthier food alternatives, a number of agricultural and food-based companies are augmenting their product and market strategies to bring new quality food ingredients to market. Calyxt, Inc. (formerly known as Cellectis Plant Sciences, Inc) is an agriculture biotechnology company that has a similar strategy as ours and is using gene editing technology to create healthier specialty food ingredients and agriculturally advantageous food crops.
- *Large Agricultural Biotechnology, Seed, and Chemical Companies:* According to Phillips McDougall, the leading 10 seed and trait companies as a group invested $3.9 billion in seed and trait research and development in 2017. This includes conventional and advanced plant breeding, as well as biotechnology and gene-editing trait development. According to Phillips McDougall, only a limited number of companies have been actively involved in new trait discovery, development, and commercialization: Corteva (formerly DuPont Pioneer and Dow), Syngenta, BASF, Bayer (including former Monsanto), KWS, and Genective (a joint venture between KWS and Limagrain). Many of these companies have substantially larger budgets for gene discovery, research, development, and product commercialization than we do. Some of these companies also have substantial resources and experience managing the regulatory process for new GM seed traits. Each of Corteva, Syngenta, and Bayer, which accounted for 87% of the 2017 seed trait research and development spend noted above, also have significant chemical crop protection background and businesses. The trait pipelines of these companies are heavily weighted toward biotic stress traits, although they also have significant programs aimed at development of abiotic stress traits and increasingly on output traits such as nutritional content. While these companies have internal programs that may compete with our own, they also seek new traits externally and, as such, some of them either currently are, or may in the future be, our collaborators.

- *Trait Research and Development Companies:* There are a number of companies that specialize in research and development of agricultural yield and product quality traits, and we believe that a dozen or more companies, including Ebbu (acquired by Cannopy Growth), Front Range Biosciences, Segra, Yield 10, Arista, Benson Hill Biosystems, Evogene and Keygene, among others, are competitors in our field. We believe that these companies typically focus on a limited number of traits, and do not generally have the product development and regulatory infrastructure necessary to bring traits to market. Therefore, they typically license trait technologies to large industry players with in-house development and regulatory capabilities at a relatively early stage of development. In the development of nutritional traits using non-GM methods, companies like Calyxt and Arista Cereal Technologies are competitors who are also developing quality traits in wheat and other crops.
- *Companies Focused on the Development and Commercialization of Microbial Crop Enhancements:* The use of microbial products to enhance crop performance via application to soil, seed, or to crops directly is an area where increased research and development activity has been underway for the past decade or more. We believe that there are more than 20 companies of varying size working in this space. There have been a number of acquisitions, including Becker Underwood by BASF, and joint collaborations in this space but multiple independent companies remain, including Verdesian, Marrone Bioinnovations, Biagro Agrinos, Indigo Agriculture, and Bioconsortia. While these companies could be considered to compete with us as their products seek to improve crop yields, we believe that such products and our traits may be additive, or synergistic, to our future products in terms of increasing crop yields.
- *Companies Focused on Farming Data Management, or Precision Agriculture:* Within the past several years there has been a rapid increase in technologies and companies focused on acquiring, analyzing, and acting upon data in ways that may improve farm economics via increased crop yield and more efficient management of crop production inputs. Technical approaches include weather prediction and monitoring, high-density field and crop imaging systems, precision field soil and yield mapping, and others. Companies focusing on this space include Climate Corporation (acquired by Monsanto), Granular (acquired by DuPont), Farmers Business Network, Farmers Edge, Trimble, Planet Labs, Ceres Imaging, Blue River Technologies, and others. While these products are potentially competitive with us for increasing crop yields, we believe that certain of these products could also be additive or synergistic with our traits.
- *Agricultural Research Universities and Institutions:* Given the global importance of agriculture, numerous agricultural research universities and institutions around the world focus on basic and applied research aimed at increasing crop yield. Most of this publicly funded research is focused on basic research. Many public research programs aim to understand basic biological processes and do not necessarily engage in further development and commercialization of discovered traits. While these programs are potentially competitive with us, we view them primarily as sources of innovation that are fully compatible with our business model. We have an established track record of working closely and effectively with public research programs, including a number from the U.S., Canada, Bangladesh, Japan, Australia, Ireland, and elsewhere.

We believe that we are uniquely positioned at the nexus of basic research and commercial product development. Unlike many companies in our space, we generally do not compete in the area of basic research. Our focus is on development and validation and, therefore, we provide a value-added link by which basic research can be brought to market. Additionally, uncertainty regarding the classification – as GM or not - of gene-editing technologies like CRISPR by regulatory authorities in certain geographies, may increase interest in our proprietary TILLING platform and libraries as a mechanism for new trait development. While internal programs at the largest seed and technology companies are competitive with ours in some cases, we are technology providers to some of these companies, and we have numerous collaborations with many of them. To remain competitive, we are pursuing multiple strategies, including further building our non-GM pipeline of new technologies, increasing the scope and range of our field-testing activities, and continuing to protect our intellectual property rights in key jurisdictions globally.

Research and Development

As of December 31, 2018, we had 24 full-time employees dedicated to research and development, four of whom are development and field personnel focused on demonstration and research field trials. Our research and development team possesses technical expertise in molecular biology, biochemistry, genetics, genetic engineering, analytical chemistry, and plant physiology. Our research and development activities are conducted principally at our Davis, California facility, with ongoing field trials conducted in American Falls, Idaho; Brawley, California, Yuma, Arizona; and numerous other locations throughout the United States, as well as locations managed by our collaborators worldwide. We have made, and will continue to make, substantial investments in research and development. Our research and development expenses were $6.1 million and $7.4 million in the years ended December 31, 2018 and 2017, respectively.

Employees

As of December 31, 2018, we had 44 full-time employees, of whom three hold doctorate degrees. Approximately 24 employees are engaged in research and development and regulatory activities and 20 in management, operations, accounting/finance, legal and administration. We believe our employee relations to be good. None of our employees are represented by a labor union or collective bargaining agreement.

Facilities

Our corporate headquarters are located in Davis, California, in a facility consisting of approximately 16,280 square feet of office, laboratory and growth chamber space under a lease which expires on June 31, 2023. This facility accommodates research and development, operations, analytical services, regulatory and administrative activities. Our administrative offices in Phoenix, Arizona, consist of 2,976 square feet under a lease expires on December 31, 2021. The facility accommodates our finance, legal and other administrative activities, as well as sales and marketing activities for our SONOVA products. We lease greenhouse space and farm land for agricultural use in Northern California as well as farmland in Idaho. We also lease office and warehouse space in Idaho under a lease that expires on December 31, 2021. Our Seattle research location closed in March 2017.

We believe that our leased facilities are adequate to meet our current needs and that, if needed, suitable additional or alternative space will be available to accommodate our operations.

Item 1A. Risk Factors.

You should carefully consider the following risk factors, in addition to the other information contained in this report on Form 10K, including the section of this report titled "Management's Discussion and Analysis of Financial Condition and Results of Operations" and our financial statements and related notes. If any of the events described in the following risk factors and the risks described elsewhere in this report occurs, our business, operating results and financial condition could be seriously harmed. This report on Form 10K also contains forward-looking statements that involve risks and uncertainties. Our actual results could differ materially from those anticipated in the forwardlooking statements as a result of factors that are described below and elsewhere in this report.

Risks Related to Our Business and Our Industry

We or our collaborators may not be successful in developing commercial products that incorporate our traits.

Our future growth depends on our ability to identify genes that will improve selected crop traits and license these genes to our collaborators to develop and commercialize seeds that contain the genes. Pursuant to our collaboration agreements, we are entitled to share in the revenues from the sale of products that integrate our trait. We expect it will take between nine and eighteen months before the first seeds integrating our agricultural yield traits complete the development process and become commercially available for sale, resulting in revenues for us. However, the development process could take longer than we anticipate or could ultimately fail to succeed in commercialization for any of the following reasons:

- our traits may not be successfully validated in one or more target crops;
- our traits may not have the desired effect sought by our collaborators in the relevant crop or geography, or under certain environmental conditions;

- relevant milestones under our agreements with collaborators may not be achieved; and
- we or our collaborators may be unable to complete the regulatory process for the products containing our traits.

If products containing our traits are never commercialized or are commercialized on a slower timeline than we anticipate, our ability to generate revenues and become profitable, as well as our long-term growth strategy, would be materially and adversely affected. For example, the development processes for several of our key agricultural yield traits have experienced delays related to regulatory matters, particularly in India, and we expect that these development processes may continue to face delays, which have negatively impacted the commercialization timelines for products containing such traits.

Even if we or our collaborators are successful in developing commercial products that incorporate our traits, such products may not achieve commercial success.

Our long-term growth strategy is dependent upon our or our collaborators' ability to incorporate our traits into a wide range of crops with global scope. Even if we or our collaborators are able to develop commercial products that incorporate our traits, any such products may not achieve commercial success as quickly as we project, or at all, for one or more of the following reasons, among others:

- products may fail to be effective in particular crops, geographies or circumstances, limiting their commercialization potential;
- our competitors may launch competing or more effective traits or products;
- the market for abiotic seed traits is evolving and not well established, and the market opportunities for any product we or our collaborators develop may be smaller than we or our collaborators believe;
- as we do not have a sales or marketing infrastructure for our agricultural yield traits, we depend entirely on our collaborators to commercialize our products, and they may fail to devote the necessary resources and attention to sell, market and distribute our current or any future products effectively;
- significant fluctuations in market prices for agricultural inputs and crops could have an adverse effect on the value of our traits;
- farmers are generally cautious in their adoption of new products and technologies, with conservative initial purchases and proof of product required prior to widespread deployment, and accordingly, it may take several growing seasons for farmers to adopt our or our collaborators' products on a large scale;
- farmers may reuse certain non-hybrid GM seeds from prior growing seasons in violation of applicable seed license agreements;
- our collaborators may not be able to produce high-quality seeds in sufficient amounts to meet demand; and
- our collaborators may decide, for whatever reason, not to commercialize products containing our traits.

Our financial condition and results of operations could be materially and adversely affected if any of the above were to occur.

Our product development cycle is lengthy and uncertain, and we may never earn revenues from the sale of products containing our traits.

Research and development in the seed, agricultural biotechnology, and larger agriculture industries is expensive, prolonged, and entails considerable uncertainty. We and our collaborators may spend many years and dedicate significant financial and other resources, developing traits that will never be commercialized. The process of discovering, developing, and commercializing a seed trait through either genetic modification or advanced breeding involves multiple phases, and it may require from six to thirteen years or more from discovery to commercialization. The length of the process may vary depending on one or more of the complexities of the trait, the particular crop, and the intended geographical market involved. This long product development cycle is in large part attributable to the nature-driven breeding period for a commercial product, as well as a lengthy regulatory process.

There are currently multiple products in development incorporating our traits, each of which consists of the application of a specific seed trait to a specific crop. Although our SONOVA products are on the market currently, we expect that it will take at least nine to eighteen months before the first products containing our agricultural yield traits complete the development process and become commercially available. However, we have little to no certainty as to which, if any, of these products will eventually reach commercialization in this timeframe or at all. Because of the long product development cycle and the complexities and uncertainties associated with agricultural biotechnology research, there is significant uncertainty as to whether we will ever generate revenues from the sale of products containing one of our traits and, even if such products reach commercialization, any resulting revenues may come at a later time than we currently anticipate.

We have a history of significant losses, which we expect to continue, and we may never achieve or maintain profitability.

We have incurred significant net losses since our formation in 2002 and expect to continue to incur net losses for the foreseeable future. We incurred net losses of $13.5 million, and $15.7 million for the years ended December 31, 2018 and 2017, respectively. As of December 31, 2018, we had an accumulated deficit of $178.4 million. Net cash used in operations was $13.6 million and $14 million for the years ended December 31, 2018 and 2017, respectively. We expect to continue to incur losses until we begin generating revenues from the sale of products containing traits we are currently developing, which we expect will not occur for nine to eighteen months, if at all. Because we have incurred and will continue to incur significant costs and expenses for these efforts before we obtain any incremental revenues from the sale of seeds incorporating our traits, our losses in future periods could be even more significant. In addition, we may find our development efforts are more expensive than we anticipate or that they do not generate revenues in the time period we anticipate, which would further increase our losses. If we are unable to adequately control the costs associated with operating our business, including costs of development and commercialization of our traits, our business, financial condition, operating results, and prospects will suffer.

In addition, our ability to generate meaningful revenues and achieve and maintain profitability depends on our ability, alone or with strategic collaborators, to successfully complete the development of and complete the regulatory process to commercialize our traits. Most of our revenues since inception have consisted of upfront and milestone payments associated with our contract research and license agreements. Additional revenues from these agreements are largely dependent on successful development of our traits by us or our collaborators. To date, we have not generated any significant revenues from product sales other than from our SONOVA products, and we do not otherwise anticipate generating revenues from product sales other than from sales of our SONOVA products for a least nine to eighteen months. If products containing our traits fail to achieve market acceptance or generate significant revenues, we may never become profitable.

We require additional financing and may not be able to obtain such financing on favorable terms, if at all, which could force us to delay, reduce, or eliminate our research and development activities.

We will continue to need capital to fund our research and development projects and to provide working capital to fund other aspects of our business. If our capital resources are insufficient to meet our capital requirements, we will have to raise additional funds. If future financings involve the issuance of equity securities, our existing stockholders would suffer dilution. If we are able to raise debt financing, we may be subject to restrictive covenants that limit our operating flexibility. We may not be able to raise sufficient additional funds on terms that are favorable to us, if at all. If we fail to raise sufficient funds and continue to incur losses, our ability to fund our operations, take advantage of strategic opportunities, develop and commercialize products or technologies, or otherwise respond to competitive pressures could be significantly limited. If this happens, we may be forced to delay or terminate research and development programs or the commercialization of products or curtail operations. If adequate funds are not available, we will not be able to successfully execute on our business strategy or continue our business.

If ongoing or future field trials by us or our collaborators are unsuccessful, we may be unable to complete the regulatory process for, or commercialize, our products in development on a timely basis.

The successful completion of field trials in the United States and foreign locations is critical to the success of product development and marketing efforts for products containing our traits. If our ongoing or future field trials, or those of our collaborators, are unsuccessful or produce inconsistent results or unanticipated adverse effects on crops or on non-target organisms, or if we or our collaborators are unable to collect reliable data, regulatory review of products in development containing our traits could be delayed or commercialization of products in development containing our traits may not be possible. In addition, more than one growing season may be required to collect sufficient data to develop or market a product containing our traits, and it may be necessary to collect data from different geographies to prove performance for customer adoption. Even in cases where field trials are successful, we cannot be certain that additional field trials conducted on a greater number of acres, or in different crops or geographies, will be successful. Generally, our collaborators conduct these field trials, or we pay third parties, such as farmers, consultants, contractors, and universities, to conduct field trials on our behalf. Poor trial execution or data collection, failure to follow required agronomic practices, regulatory requirements, or mishandling of products in development by our collaborators or these third parties could impair the success of these field trials.

Many factors that may adversely affect the success of our field trials are beyond our control, including weather and climatic variations, such as drought or floods, severe heat or frost, hail, tornadoes and hurricanes, uncommon pests and diseases, or acts of protest or vandalism. For example, if there was prolonged or permanent disruption to the electricity, climate control, or water supply operating systems in our greenhouses or laboratories, the crops in which we or our collaborators are testing our traits and the samples we or our collaborators store in freezers, both of which are essential to our research and development activities, could be severely damaged or destroyed, adversely affecting these activities and thereby our business and results of operations. Unfavorable weather conditions can also reduce both acreage planted and incidence, or timing of, certain crop diseases or pest infestations, each of which may halt or delay our field trials. For example, in 2018, one of our trials was subjected to frost, as a result of which seed production and test results were compromised. We had to incur additional costs to repeat the trials in the following season. We have also experienced crop failures in the past for then-unknown reasons, causing delays in our achievement of milestones and delivery of results and necessitating that we repeat the impacted field trials. Any field test failure we may experience may not be covered by insurance and, therefore, could result in increased cost for the field trials and development of our traits, which may negatively impact our business and results of operations. Additionally, we are subject to U.S. Department of Agriculture, or USDA, regulations, which may require us to abandon a field trial or to purchase and destroy neighboring crops that are planted after our field trials have commenced. For example, while conducting early field trials for GLA safflower oil, we were forced to purchase and destroy an adjacent safflower crop when the placement of bee hives by a third party altered the required isolation distance between our crop and the neighboring crop, requiring us to either purchase and destroy the adjacent crop or abandon our field trial. In order to prevent the significant delays that would result from terminating our field trial, we decided to purchase and destroy the neighboring crop at a cost of approximately $30,000. Similar factors outside of our control can create substantial volatility relating to our business and results of operations.

Competition in traits and seeds is intense and requires continuous technological development, and, if we are unable to compete effectively, our financial results will suffer.

We face significant competition in the markets in which we operate. The markets for traits and agricultural biotechnology products are intensely competitive and rapidly changing. In most segments of the seed and agricultural biotechnology market, the number of products available to consumers is steadily increasing as new products are introduced. At the same time, the expiration of patents covering existing products reduces the barriers to entry for competitors. We may be unable to compete successfully against our current and future competitors, which may result in price reductions, reduced margins and the inability to achieve market acceptance for products containing our traits. In addition, several of our competitors have substantially greater financial, marketing, sales, distribution, research and development, and technical resources than us, and some of our collaborators have more experience in research and development, regulatory matters, manufacturing, and marketing. We anticipate increased competition in the future as new companies enter the market and new technologies become available. Our technologies may be rendered obsolete or uneconomical by technological advances or entirely different approaches developed by one or more of our competitors, which will prevent or limit our ability to generate revenues from the commercialization of our traits being developed.

We derive a significant portion of our current revenues from government agencies, which may not continue in the future and which may expose us to government audits and potential penalties.

We historically have derived a significant portion of our revenues from grants from U.S. government agencies. Our ability to obtain grants is subject to the availability of funds under applicable government programs and approval of our applications to participate in such programs. The application process for these grants is highly competitive. We may not be successful in obtaining any additional grants. Once we successfully obtain a grant, the awarding U.S. government agency has the right to decrease or discontinue funding on such grant at any time. The recent political focus on reducing spending at the U.S. federal and state levels may reduce the scope and amount of funds dedicated to seed and agricultural biotechnology innovations, if such funds continue to be available at all. To the extent that we are unsuccessful in obtaining any additional government grants in the future or if funding is discontinued on an existing grant, we would lose a significant source of our current revenues.

To the extent that we do not comply with the specific requirements of a grant, amounts we invoice may not be paid and any of our existing grants or new grants that we may obtain in the future may be terminated or modified. In addition, our activities funded by our government grants are subject to audits by U.S. government agencies. As part of an audit, these agencies may review our performance, cost structures and compliance with applicable laws, regulations and standards, and the terms and conditions of the grant. An audit could result in a material adjustment to our results of operations and financial condition. Moreover, if an audit uncovers improper or illegal activities, we may also be subject to civil and criminal penalties and administrative sanctions, including termination of contracts, forfeiture of profits, suspension of payments, or fines, and we may be suspended or prohibited from doing business with the government. In addition, serious reputational harm or significant adverse financial effects could occur if allegations of impropriety are made against us, even if we are ultimately found to have done no wrong.

A significant portion of our revenues to date are from a limited number of strategic collaborations, and the termination of these collaborations would have a material adverse effect on our results of operations.

We have historically derived a substantial amount of our revenues from a limited number of strategic collaborations, under which we have generated revenues through licensing arrangements such as research and development payments, up-front payments, milestone payments, and, once a product is commercialized, a portion of the commercial value of the trait. A small number of commercial partners are expected to continue to account for a substantial amount of our revenues for the next several years. The termination or non-renewal of our arrangements with our commercial partners would have a material adverse effect on our business, financial condition, results of operations, and prospects.

We expect to derive a substantial portion of our future revenues from commercial products sold outside the United States, which subjects us to additional business risks.

A significant number of our research and collaboration agreements include products under development for markets outside the United States. Our collaborators' operations in these regions are subject to a variety of risks, including different regulatory requirements, uncertainty of contract and intellectual property rights, unstable political and regulatory environments, economic and fiscal instability, tariffs and other import and trade restrictions, restrictions on the ability to repatriate funds, business cultures accepting of various levels of corruption, and the impact of anti-corruption laws. These risks could result in additional cost, loss of materials, and delays in our commercialization timeline in international markets and have a negative effect on our operating results.

Revenues generated outside the United States could also be subject to increased difficulty in collecting delinquent or unpaid accounts receivables, adverse tax consequences, currency and exchange rate fluctuations, relatively high inflation, exchange control regulations, and governmental pricing directives. Acts of terror or war may impair our ability to operate in particular countries or regions and may impede the flow of goods and services between countries. Customers in these and other markets may be unable to purchase our products if their economies deteriorate, or it could become more expensive for them to purchase imported products in their local currency or sell their commodities at prevailing international prices, and we may be unable to collect receivables from such customers. If any of these risks materialize, our results of operations and profitability could be harmed.

We or our collaborators may fail to perform our respective obligations under contract research and collaboration agreements.

We are obligated under certain contract research agreements to perform research activities over a particular period of time. If we fail to perform our obligations under these agreements, in some cases our collaborators may terminate our agreements with them and in other cases our collaborators' obligations may be reduced and, as a result, our anticipated revenues may decrease. In addition, any of our collaborators may fail to perform their obligations under the timelines in our collaboration agreements, which may delay development and commercialization of products containing our traits and materially and adversely affect our future results of operations.

Furthermore, the various payments we receive from our collaborators are a significant source of our current revenues and are expected to be the largest source of our revenues in the future. If our collaborators do not make these payments, either due to financial hardship, disagreement as to whether such payments are owed under the relevant collaboration agreement, or for any other reason, our results of operations and business could be materially and adversely affected. If disagreements with a collaborator arise, any dispute with such collaborator may negatively affect our relationship with one or more of our other collaborators and may hinder our ability to enter into future collaboration agreements, each of which could negatively impact our business and results of operations.

Our prospects for successful development and commercialization of our products are dependent upon the research, development, commercialization, and marketing efforts of our collaborators.

We primarily rely on third parties for research, development, commercialization, and marketing of our products and products in development. Other than as provided for in our collaboration agreements, we have no control over the resources, time and effort that our collaborators may devote to the development of products incorporating our traits and have limited access to information regarding or resulting from such programs. We are dependent on our third-party collaborators to fund and conduct the research and development of product candidates, to complete the regulatory process, and for the successful marketing and commercialization of one or more of such products or products in development. Such success will be subject to significant uncertainty.

Our ability to recognize revenues from successful collaborations may be impaired by multiple factors including:

- a collaborator may shift its priorities and resources away from our programs due to a change in business strategies, or a merger, acquisition, sale, or downsizing of its company or business unit;
- a collaborator may cease development in a specific crop area that is the subject of a collaboration agreement;
- a collaborator may change the success criteria for a particular program or product in development, thereby delaying or ceasing development of such program or product in development;
- a significant delay in initiation of certain development activities by a collaborator will also delay payment of milestones tied to such activities, thereby impacting our ability to fund our own activities;
- a collaborator could develop or acquire a product that competes, either directly or indirectly, with our current products or any future products;
- a collaborator with commercialization obligations may not commit sufficient financial or human resources to the marketing, distribution, or sale of a product;
- a collaborator with manufacturing responsibilities may encounter regulatory, resource, or quality issues and be unable to meet demand requirements;
- a collaborator may exercise its rights under the agreement to terminate our collaboration;
- a dispute may arise between us and a collaborator concerning the development and commercialization of a product in development, resulting in a delay in milestones, royalty payments, or termination of a program and possibly resulting in costly litigation or arbitration that may divert management attention and resources;

- a collaborator may not adequately protect the intellectual property rights associated with a product or product in development; and
- a collaborator may use our proprietary information or intellectual property in such a way as to expose us to litigation from a third party.

If our collaborators do not perform in the manner we expect or fulfill their responsibilities in a timely manner, or at all, the development, regulatory, and commercialization process could be delayed, terminated, or otherwise unsuccessful. Conflicts between us and our collaborators may arise. In the event of termination of one or more of our collaboration agreements, it may become necessary for us to assume the responsibility for any terminated products or products in development at our own expense or seek new collaborators. In that event, we likely would be required to limit the size and scope of one or more of our independent programs or increase our expenditures and seek additional funding, which may not be available on acceptable terms or at all, and our business may be materially and adversely affected.

We rely on third parties to conduct, monitor, support, and oversee field trials and, in some cases, to maintain regulatory files for those products in development, and any performance issues by third parties, or our inability to engage third parties on acceptable terms, may impact our or our collaborators' ability to complete the regulatory process for or commercialize such products.

We rely on third parties, including farmers, to conduct, monitor, support, and oversee field trials. As a result, we have less control over the timing and cost of these trials than if we conducted these trials with our own personnel. If we are unable to maintain or enter into agreements with these third parties on acceptable terms, or if any such engagement is terminated prematurely, we may be unable to conduct and complete our trials in the manner we anticipate. In addition, there is no guarantee that these third parties will devote adequate time and resources to our studies or perform as required by our contract or in accordance with regulatory requirements, including maintenance of field trial information regarding our products in development. If these third parties fail to meet expected deadlines, fail to transfer to us any regulatory information in a timely manner, fail to adhere to protocols, or fail to act in accordance with regulatory requirements or our agreements with them, or if they otherwise perform in a substandard manner or in a way that compromises the quality or accuracy of their activities or the data they obtain, then field trials of our products in development may be extended or delayed with additional costs incurred, or our data may be rejected by the USDA, the U.S. Food and Drug Administration, or FDA, the U.S. Environmental Protection Agency, or EPA, or other regulatory agencies. Ultimately, we are responsible for ensuring that each of our field trials is conducted in accordance with the applicable protocol, legal, regulatory and scientific standards, and our reliance on third parties does not relieve us of our responsibilities.

If our relationship with any of these third parties is terminated, we may be unable to enter into arrangements with alternative parties on commercially reasonable terms, or at all. Switching or adding farmers or other suppliers can involve substantial cost and require extensive management time and focus. In addition, there is a natural transition period when a new farmer or other third party commences work. As a result, delays may occur, which can materially impact our ability to meet our desired development timelines. If we are required to seek alternative supply arrangements, the resulting delays and potential inability to find a suitable replacement could materially and adversely impact our business.

In addition, recently there has been an increasing trend towards consolidation in the agricultural biotechnology industry. For example, in 2017 and 2018, several major agricultural companies have merged, namely Dow and DuPont, ChemChina and Syngenta and Bayer acquired Monsanto. Consolidation among our competitors and third parties upon whom we rely could lead to a changing competitive landscape, capabilities, and market share allocations, which could have an adverse effect on our business and operations.

Most of our collaborators have significant resources and development capabilities and may develop their own products that compete with or negatively impact the advancement or sale of products containing our traits.

Most of our collaborators are significantly larger than us and may have substantially greater resources and development capabilities. As a result, we are subject to competition from many of our collaborators, who could develop or pursue competing products and traits that may ultimately prove more commercially viable than our traits. In addition, former collaborators, by virtue of having had access to our proprietary technology, may utilize this insight for their own development efforts, despite the fact that our collaboration agreements prohibit such use. The development or launch of a competing product by a collaborator may adversely affect the advancement and commercialization of any traits we develop and any associated research and development and milestone payments and value-sharing payments we receive from the sale of products containing our traits.

Our joint venture agreements could present a number of challenges that may have a material adverse effect on our business, financial condition, and results of operations.

We currently participate in one joint venture, Verdeca LLC, which focuses on the development and deregulation of soybean traits. We may enter into additional joint ventures in the future. Our joint venture arrangements may present financial, managerial, and operational challenges, including potential disputes, liabilities, or contingencies and may involve risks not otherwise present when operating independently, including:

- our joint venture partners may have business interests, goals or cultures that are or become inconsistent with our business interests, goals or culture;
- our joint venture partners may share certain approval rights,
- we may incur liabilities or losses as a result of an action taken by the joint venture or our joint venture partners;
- our joint venture partners may take action contrary to our instructions, requests, policies or objectives, which could reduce our return on investment, harm our reputation or restrict our ability to run our business; and
- disputes between us and our joint venture partners may result in delays, litigation or operational impasses.

The risks described above or the failure to continue any joint venture or joint development arrangement or to resolve disagreements with our current or future joint venture partners could materially and adversely affect our ability to transact the business that is the subject of such joint venture, which would in turn negatively affect our financial condition and results of operations.

We and our collaborators may disagree over our right to receive payments under our collaboration agreements, potentially resulting in costly litigation and loss of reputation.

Our ability to receive payments under our collaboration agreements depends on our ability to clearly delineate our rights under those agreements. We typically license our intellectual property to our collaborators, who then develop and commercialize seeds with improved traits. However, a collaborator may use our intellectual property without our permission, dispute our ownership of certain intellectual property rights, or argue that our intellectual property does not cover, or add value to, their marketed product. If a dispute arises, it may result in costly patent office procedures and litigation, and our collaborator may refuse to pay us while the dispute is ongoing. Furthermore, regardless of any resort to legal action, a dispute with a collaborator over intellectual property rights may damage our relationship with that collaborator and may also harm our reputation in the industry.

Even if we are entitled to payments from our collaborators, we may not actually receive these payments, or we may experience difficulties in collecting the payments to which we believe we are entitled. After our collaborators launch commercial products containing our licensed traits, we will need to rely on the good faith of our collaborators to report to us the sales they earn from these products and to accurately calculate the payments we are entitled to, a process that will involve complicated and difficult calculations. Although we seek to address these concerns in our collaboration agreements by reserving our right to audit financial records, such provisions may not be effective.

Our business is subject to various government regulations and if we or our collaborators are unable to timely complete the regulatory process for our products in development, our or our collaborators' ability to market our traits could be delayed, prevented or limited.

Our business is generally subject to two types of regulations: regulations that apply to how we and our collaborators operate and regulations that apply to products containing our traits. We apply for and maintain the regulatory permits necessary for our operations, particularly those covering our field trials, while we or our collaborators apply for and maintain regulatory approvals necessary for the commercialization of products containing our seed traits. The large-scale field trials that our collaborators conduct during advanced stages of product development are subject to regulations similar to those to which we are subject. Even if we and our collaborators make timely and appropriate applications for regulatory permits for our field trials, government delays in issuing such permits can significantly affect the development timelines for our products, particularly if the planting period for a crop growing season expires before the necessary permits are obtained. For example, Mahyco, our collaborator in India has encountered and continues to encounter delays in obtaining necessary regulatory permits for field trials, and these delays have had a negative impact on the commercialization timelines for certain of our products and may have additional future negative impacts. Pursuant to our collaboration agreements, our collaborators also apply for the requisite regulatory approvals prior to commercialization of products containing our traits. In most of our key target markets, regulatory approvals must be received prior to the importation of genetically modified products. These regulatory processes may be complex; for example, the U.S. federal government's regulation of biotechnology is divided among the EPA, which regulates activity related to the use of plant pesticides and herbicides, the USDA, which regulates the import, field testing, interstate movement, and environmental release of specific technologies that may be used in the creation of genetically modified plants, and the FDA, which regulates foods derived from new plant varieties.

In addition to regulation by the U.S. government, products containing our biotech traits may be subject to regulation in each country in which such products are tested or sold. International regulations may vary from country to country and from those of the United States. The difference in regulations under U.S. law and the laws of foreign countries may be significant and, in order to comply with the laws of foreign countries, we may have to implement global changes to our products or business practices. Such changes may result in additional expense to us and either reduce or delay product development or sales. Additionally, we or our collaborators may be required to obtain certifications or approvals by foreign governments to test and sell the products in foreign countries.

The regulatory process is expensive and time-consuming, and the time required to complete the process is difficult to predict and depends upon numerous factors, including the substantial discretion of the regulatory authorities. Other than for our SONOVA products, neither we nor our collaborators have completed all phases of the regulatory process for any of our products in development. Our traits could require a significantly longer time to complete the regulatory process than expected, or may never gain approval, even if we and our collaborators expend substantial time and resources seeking such approval. A delay or denial of regulatory approval could delay or prevent our ability to generate revenues and to achieve profitability. Changes in regulatory review policies during the development period of any of our traits, changes in, or the enactment of, additional regulations or statutes, or changes in regulatory review practices for a submitted product application may cause a delay in obtaining approval or result in the rejection of an application for regulatory approval. Regulatory approval, if obtained, may be made subject to limitations on the indicated uses for which we or our collaborators may market a product. These limitations could adversely affect our potential revenues. Failure to comply with applicable regulatory requirements may, among other things, result in fines, suspensions of regulatory approvals, product recalls, product seizures, operating restrictions, and criminal prosecution. We have on certain occasions notified the USDA of instances of noncompliance with regulations. Although these occasions did not result in any enforcement actions, we may have occasions of noncompliance in the future that result in USDA or other governmental agency enforcement action.

Consumer resistance to genetically modified organisms may negatively affect our public image and reduce sales of seeds containing our traits.

We are active in the field of agricultural biotechnology research and development in seeds and crop protection, including GM seeds. Foods made from such seeds are not accepted by many consumers due to concerns over such products' effects on food safety and the environment. The high public profile of biotechnology in food production and lack of consumer acceptance of products to which we have devoted substantial resources could negatively affect our public image and results of operations. The current resistance from consumer groups,

particularly in Europe, to GM crops not only limits our access to such markets, but also has the potential to spread to and influence the acceptance of products developed through biotechnology in other regions of the world. For example, we temporarily suspended certain initiatives in response to legislative requirements in Vermont related to labeling of food products containing GM ingredients until it was determined that there would be clarity and uniformity in nationwide food labeling requirements. Certain labeling-related initiatives have heightened consumer awareness of GM crops generally and may make consumers less likely to purchase food products containing GM ingredients, which could have a negative impact on the commercial success of products that incorporate our traits and materially and adversely affect our financial condition and results of operations.

Governmental restrictions on the testing, production, and importation of GM crops may negatively affect our business and results of operations.

The production of certain GM crops is effectively prohibited in certain countries, including throughout the European Union, which limits our commercial opportunities and may influence regulators in other countries to limit or ban the testing, production, or importation of GM crops and products of GM crops. Our GM crops are grown principally in North America, South America, India and Australia, where there are fewer restrictions on the production of GM crops. If these or other countries where our GM crops are grown enact laws or regulations that ban the production of such crops or make regulations more stringent, we could experience a longer product development cycle for our products, encounter difficulty obtaining intellectual property protection, and may even have to abandon projects related to certain crops or geographies, any of which would negatively affect our business and results of operations. Furthermore, any changes in such laws and regulations or consumer acceptance of our GM crops and products made from these crops could negatively impact our collaborators, who in turn might terminate or reduce the scope of their collaborations with us or seek to alter the financial terms of our agreements with them.

Changes in laws and regulations to which we are subject, or to which we may become subject in the future, may materially increase our costs of operation, decrease our operating revenues, and disrupt our business.

Laws and regulatory standards and procedures that impact our business are continuously changing. Responding to these changes and meeting existing and new requirements may be costly and burdensome. Changes in laws and regulations could:

- impair or eliminate our ability, or increase our cost, to develop our traits, including validating our products in development through field trials;
- increase our compliance and other costs of doing business through increases in the cost to patent or otherwise protect our intellectual property or increases in the cost to our collaborators to complete the regulatory process to commercialize and market the products we develop with them;
- render any products less profitable, obsolete, or less attractive compared to competing products;
- affect our collaborators' willingness to do business with us;
- reduce the amount of revenues we receive from our collaborators; and
- discourage our collaborators from offering, and consumers from purchasing, products that incorporate our traits.

Any of these events could have a material adverse effect on our business, results of operations, and financial condition. Legislators and regulators have increased their focus on plant biotechnology in recent years, with particular attention paid to GM crops.

Our future growth relies on the ability of our collaborators to commercialize and market our products in development, and any restrictions on such activities could materially and adversely impact our business and results of operations. Any changes in regulations in countries where GM crops are grown or imported could result in our collaborators being unable or unwilling to develop, commercialize, or sell products that incorporate our traits. Any changes to these existing laws and regulations may also materially increase our costs of operation, decrease our operating revenues, and disrupt our business.

The unintended presence of our traits in other products or plants may negatively affect us.

Trace amounts of our traits may unintentionally be found outside our containment area in the products of third parties, which may result in negative publicity and claims of liability brought by such third parties against us. Furthermore, in the event of an unintended dissemination of our genetically engineered materials to the environment or the presence of unintended but unavoidable trace amounts, sometimes called "adventitious presence," of our traits in conventional seed, or in the grain or products produced from conventional or organic crops, we could be subject to claims by multiple parties, including environmental advocacy groups, as well as governmental actions such as mandated crop destruction, product recalls, or additional stewardship practices and environmental cleanup or monitoring.

Loss of or damage to our germplasm collection would significantly slow our product development efforts.

We have developed and maintain a comprehensive collection of germplasm through strategic collaborations with leading institutions, which we utilize in our non-GM programs. Germplasm comprises collections of genetic resources covering the diversity of a crop, the attributes of which are inherited from generation to generation. Germplasm is a key strategic asset since it forms the basis of seed development programs. To the extent that we lose access to such germplasm because of the termination or breach of our collaboration agreements, our product development capabilities would be severely limited. In addition, loss of or damage to these germplasm collections would significantly impair our research and development activities. Although we restrict access to our germplasm at our research facilities to protect this valuable resource, we cannot guarantee that our efforts to protect our germplasm collection will be successful. The destruction or theft of a significant portion of our germplasm collection would adversely affect our business and results of operations.

We depend on our key personnel and, if we are not able to attract and retain qualified scientific and business personnel, we may not be able to grow our business or develop and commercialize our products.

Our future performance depends on the continued services and contributions of our management team and other key employees, the loss of whose services might significantly delay or prevent the achievement of our scientific or business objectives. The replacement of any member of our management team involves significant time and costs and such loss could significantly delay or prevent the achievement of our business objectives. A member of our leadership team who has been our employee for many years and therefore, has significant experience and understanding of our business, would be difficult to replace.

Additionally, the majority of our workforce is involved in research, development, and regulatory activities. Our business is therefore dependent on our ability to recruit and maintain a highly skilled and educated workforce with expertise in a range of disciplines, including molecular biology, biochemistry, plant genetics, agronomics, mathematics, agribusiness, and other subjects relevant to our operations. All of our current employees are at-will employees, and the failure to retain or hire skilled and highly educated personnel could limit our growth and hinder our research and development efforts.

Our business is subject to the risks of earthquakes, fire, flood, crop losses and other catastrophic natural events, and security breaches, including cybersecurity incidents.

Our headquarters, certain research and development operations and our seed storage warehouse are located in Davis, California. Production of wheat is conducted in Idaho and other locations. Weather conditions, disease or pest infestation could damage the crop in spite of precautions we would normally take to avoid such losses. Our production of our SONOVA products takes place at a single facility in Northern California, and the inventory is stored in a single cold storage facility in Northern California. We take precautions to safeguard our facilities, including insurance, health and safety protocols, and off-site storage of critical research results and computer data. However, a natural disaster, such as a fire, flood, or earthquake, could cause substantial delays in our operations, damage or destroy our equipment, inventory, or development projects, and cause us to incur additional expenses. The insurance we maintain against natural disasters may not be adequate to cover our losses in any particular case.

We utilize and critically rely upon information technology systems in all aspects of our business, including increasingly large amounts of data to support our products and advance our research and development. Failure to effectively prevent, detect, and recover from the increasing number and sophistication of information security threats could result in theft, misuse, modification, and destruction of information, including trade secrets and confidential business information, and cause business disruptions, delays in research and development, and reputational damage, which could significantly affect our results of operations and financial condition.

Disruption to our IT system could adversely affect our reputation and have a material adverse effect on our business and results of operations.

Our technologies rely on our IT system to collect and analyze our genomic data, including TILLING and other experimental data, and manage our plant inventory system, which tracks every plant that we have ever produced. We can provide no assurance that our current IT system is fully protected against third-party intrusions, viruses, hacker attacks, information, or data theft, or other similar threats. Furthermore, we store significant amounts of data and, though we have back-up storage for our stored data, we cannot assure you that our back-up storage arrangements will be effective if it becomes necessary to rely on them.

If our IT system does not function properly or proves incompatible with new technologies, we could experience interruptions in data transmissions and slow response times, preventing us from completing routine research and business activities. Furthermore, disruption or failure of our IT system due to technical reasons, natural disaster, or other unanticipated catastrophic events, including power interruptions, storms, fires, floods, earthquakes, terrorist attacks, and wars could significantly impair our ability to deliver data related to our projects to our collaborators on schedule and materially and adversely affect the outcome of our collaborations, our relationships with our collaborators, our business, and our results of operations.

Our use of hazardous materials exposes us to potential liabilities.

Certain of our operations involve the storage and controlled use of hazardous materials, including laboratory chemicals, herbicides, and pesticides. This requires us to conduct our operations in compliance with applicable environmental and safety standards, and we cannot completely eliminate the risk of accidental contamination from hazardous materials. In the event of such contamination, we may be held liable for significant damages or fines, which could have a material adverse effect on our business and operating results.

Most of the licenses we grant to our collaborators to use our proprietary genes in certain crops are exclusive within certain jurisdictions, which limits our licensing opportunities.

Most of the licenses we grant our collaborators to use our proprietary genes in certain crops are exclusive within specified jurisdictions, so long as our collaborators comply with certain diligence requirements. That means that once genes are licensed to a collaborator in a specified crop or crops, we are generally prohibited from licensing those genes to any third party. The limitations imposed by these exclusive licenses could prevent us from expanding our business and increasing our product development initiatives with new collaborators, both of which could adversely affect our business and results of operations.

Our business model for discovery of genes is dependent on licensing patent rights from third parties, and any disruption of this licensing process could adversely affect our competitive position and business prospects.

Our business model involves acquiring technologies that have achieved proof of concept through rigorous development and testing by third-party basic researchers in order to avoid the significant risks and high costs associated with basic research. Only a small number of the genes we evaluate for acquisition are likely to provide viable commercial candidates and an even more limited number, if any, are likely to be commercialized by us or our collaborators. A failure by us to continue identifying genes that improve specific crop traits could make it difficult to grow our business. If we are unable to identify additional genes, we may be unable to develop new traits, which may negatively impact our ability to generate revenues.

If we are unable to enter into licensing arrangements to acquire rights to these potentially viable genes on favorable terms in the future, it may adversely affect our business. In addition, if the owners of the patents we license do not properly maintain or enforce the patents underlying such licenses, our competitive position and business prospects could be harmed. Without protection for the intellectual property we license, other companies might be able to offer substantially similar or identical products for sale, which could adversely affect our competitive business position and harm our business prospects.

If we fail to comply with our obligations under license agreements, our counterparties may have the right to terminate these agreements, in which event we may not be able to develop, manufacture, register, or market, or may be forced to cease developing, manufacturing, registering, or marketing, any product that is covered by these agreements or may face other penalties under such agreements. Such an occurrence could materially adversely affect the value of the applicable products to us and have an adverse effect on our business and result of operations.

Our commercial success depends on our ability to protect our intellectual property and our proprietary technologies and on the ability to operate without infringing the patents and other proprietary rights of third parties.

Our success will depend in part on our ability to obtain and maintain patent protection both in the United States and in other countries for any products we successfully develop. The patents and patent applications in our patent portfolio are either owned by us, exclusively licensed to us, or co-owned by us and others and exclusively licensed to us. Our ability to protect any products we successfully develop from unauthorized or infringing use by third-parties depends substantially on our ability to obtain and maintain valid and enforceable patents. Due to evolving legal standards relating to the patentability, validity and enforceability of patents covering biotechnology inventions and the scope of claims made under these patents, our ability to obtain and enforce patents is uncertain and involves complex legal and factual questions. Accordingly, rights under any issued patents may not provide us with sufficient protection for any products we successfully develop or provide sufficient protection to afford us a commercial advantage against our competitors or their competitive products or processes. In addition, we cannot guarantee that any patents will be issued from any pending or future patent applications owned by or licensed to us. Even if patents have been issued or will be issued, we cannot guarantee that the claims of these patents are, or will be, valid or enforceable, or provide us with any significant protection against competitive products or otherwise be commercially valuable to us.

The U.S. Congress passed the Leahy-Smith America Invents Act, or the America Invents Act, which was signed into law in September 2011. The America Invents Act reforms U.S. patent law in part by changing the standard for patent approval from a "first to invent" standard to a "first inventor to file" standard and developing a post-grant review system. This new legislation affects U.S. patent law in a manner that may impact our ability to obtain or maintain patent protection for current or future inventions in the U.S. or otherwise cause uncertainty as to our patent protection.

We may not have identified all patents, published applications or published literature that may affect our business, either by blocking our ability to commercialize our traits, by preventing the patentability of our traits by us, our licensors or co-owners, or by covering the same or similar technologies that may invalidate our patents, limiting the scope of our future patent claims or adversely affecting our ability to market our products. For example, patent applications are maintained in confidence for at least 18 months after their filing. In some cases, patent applications remain confidential in the USPTO for the entire time prior to issuance of a U.S. patent. Patent applications filed in countries outside the United States are not typically published until at least 18 months from their first filing date. Similarly, publication of discoveries in the scientific or patent literature often lags behind actual discoveries. Therefore, we cannot be certain that we or our licensors or co-owners were the first to invent, or the first inventors to file, patent applications on our processes, products or their uses. In the event that another party has filed a U.S. patent application covering the same invention as one of our patent applications or patents, we may have to participate in an adversarial proceeding, known as an interference, declared by the USPTO to determine priority of invention in the United States. For example, in February 2018, we initiated an interference proceeding with the USPTO concerning one of the patent applications and a patent owned by Arista Cereals Technologies Pty. Ltd. relating to our Resistant Starch Wheat products to determine priority of invention.

On August 14, 2018, the USPTO issued a decision that resulted in termination of the interference which we have since appealed. A decision on the appeal is not expected until the latter half of 2019. If we lose the appeal, the interference is finally terminated, and Arista maintains its patent. If we win the appeal, the interference resumes at the USPTO. The USPTO may determine we were the first to invent, in which case the subject matter of the interference count may be granted in a patent to us. If the USPTO determines Arista was the first to invent, in which case Arista may maintain its patent. A ruling by the USPTO in favor of Arista would not affect our current patent, nor would it preclude us from commercializing our Resistant Starch Wheat product.

Additionally, the Company is aware Arista has issued patents and pending patent applications relating to high amylose wheat. The Company believes that its products and traits relating to high amylose wheat do not infringe any valid claims under Arista's issued patents. However, there is no guarantee that a court would make the same determination, and an adverse decision would affect the Company's ability to exploit such product containing the patented claims.

If we are unable to protect the confidentiality of our trade secrets, the value of our technology could be materially and adversely affected and our business could be harmed.

We treat our proprietary technologies, including unpatented know-how and other proprietary information, as trade secrets. We seek to protect these trade secrets, in part, by entering into non-disclosure and confidentiality agreements with any third parties who have access to them, such as our consultants, independent contractors, advisors, corporate collaborators, and outside scientific collaborators. We also enter into confidentiality and invention or patent assignment agreements with employees and certain consultants. Any party with whom we have executed such an agreement could breach that agreement and disclose our proprietary information, including our trade secrets, and we may not be able to obtain adequate remedies for such breaches. Enforcing a claim that a party illegally disclosed or misappropriated a trade secret is difficult, expensive, and time consuming, and the outcome is unpredictable. In addition, if any of our trade secrets were to be lawfully obtained or independently developed by a competitor, we would have no right to prevent such third party, or those to whom they communicate such technology or information, from using that technology or information to compete with us. If any of our trade secrets were to be disclosed to or independently developed by a competitor, or if we otherwise lose protection for our trade secrets or proprietary know-how, the value of this information may be greatly reduced and our business and competitive position could be harmed.

Changes in U.S. patent law could diminish the value of patents in general, thereby impairing our ability to protect our products in development.

As an agricultural biotechnology company, our success is heavily dependent on intellectual property, particularly patents. Obtaining and enforcing patents involves technological and legal complexity, and is costly, time consuming, and inherently uncertain. In addition, the U.S. Supreme Court has ruled on several patent cases in recent years, either narrowing the scope of patent protection available in certain circumstances or weakening the rights of patent owners in certain situations. In addition to increasing uncertainty with regard to our ability to obtain patents in the future, this combination of events has created uncertainty with respect to the value of patents once obtained. Depending on decisions by the U.S. Congress, the federal courts, and the U.S. Patent and Trademark Office, the laws and regulations governing patents could change in unpredictable ways that may weaken or undermine our ability to obtain new patents or to enforce our existing patents and patents we might obtain in the future.

We may not be able to protect our intellectual property rights throughout the world.

Filing, prosecuting, maintaining, and defending patents on products in development in all countries throughout the world would be prohibitively expensive, and our intellectual property rights in some countries outside the United States are less extensive than those in the United States. In addition, the laws of some foreign countries do not protect intellectual property rights to the same extent as federal and state laws in the United States. For example, several countries outside the United States prohibit patents on plants and seeds entirely. In addition, we may at times license third-party technologies for which limited international patent protection exists and for which the time period for filing international patent applications has passed. Consequently, we are unable to prevent third parties from using intellectual property we develop or license in all countries outside the United States, or from selling or

importing products made using our intellectual property in and into the jurisdictions in which we do not have patent protection. Competitors may use our technologies in jurisdictions where we have not obtained patent protection to develop their own products, and we may be unable to prevent such competitors from importing those infringing products into territories where we have patent protection, but where enforcement is not as strong as in the United States. These products may compete with our products in development and our patents and other intellectual property rights may not be effective or sufficient to prevent them from competing in those jurisdictions. Moreover, farmers or others in the chain of commerce may raise legal challenges to our intellectual property rights or may infringe upon our intellectual property rights, including through means that may be difficult to prevent or detect, and local regulators may choose to not enforce our intellectual property rights.

Many companies have encountered significant problems in protecting and defending intellectual property rights in foreign jurisdictions where we have filed patent applications. The legal systems of certain countries have not historically favored the enforcement of patents or other intellectual property rights, which could hinder us from preventing the infringement of our patents or other intellectual property rights and result in substantial risks to us. Proceedings to enforce our patent rights in the United States or foreign jurisdictions could result in substantial costs and divert our efforts and attention from other aspects of our business, could put our patents at risk of being invalidated or interpreted narrowly and our patent applications at risk of not issuing and could provoke third parties to assert patent infringement or other claims against us. We may not prevail in any lawsuits that we initiate and the damages or other remedies awarded, if any, may not be commercially meaningful or even cover our associated legal costs. Accordingly, our efforts to enforce our intellectual property rights around the world may be inadequate to obtain a significant commercial advantage from the intellectual property that we develop or license from third parties.

If we or one of our collaborators are sued for infringing the intellectual property rights of a third party, such litigation could be costly and time consuming and could prevent us or our collaborators from developing or commercializing our products.

Our ability to generate significant revenues from our products depends on our and our collaborators' ability to develop, market and sell our products and utilize our proprietary technology without infringing the intellectual property and other rights of any third parties. In the United States and abroad there are numerous third-party patents and patent applications that may be applied toward our proprietary technology, business processes, or developed traits, some of which may be construed as containing claims that cover the subject matter of our products or intellectual property. Because of the rapid pace of technological change, the confidentiality of patent applications in some jurisdictions (including U.S. provisional patent applications), and the fact that patent applications can take many years to issue, there may be currently pending applications that are unknown to us that may later result in issued patents upon which our products in development or proprietary technologies infringe. Similarly, there may be issued patents relevant to our products in development of which we are not aware. These patents could reduce the value of the traits we develop or the plants containing our traits or, to the extent they cover key technologies on which we have unknowingly relied, require that we seek to obtain licenses or cease using the technology, no matter how valuable to our business. We may not be able to obtain such a license on commercially reasonable terms. If any third-party patent or patent application covers our intellectual property or proprietary rights and we are not able to obtain a license to it, we and our collaborators may be prevented from commercializing products containing our traits.

As the agricultural biotechnology industry continues to develop, we may become party to, or threatened with, litigation or other adverse proceedings regarding intellectual property or proprietary rights in our technology, processes, or developed traits. Third parties may assert claims based on existing or future intellectual property rights and the outcome of any proceedings is subject to uncertainties that cannot be adequately quantified in advance. Any litigation proceedings could be costly and time consuming, and negative outcomes could result in liability for monetary damages, including treble damages and attorneys' fees, if we are found to have willfully infringed a patent. There is also no guarantee that we would be able to obtain a license under such infringed intellectual property on commercially reasonable terms or at all. A finding of infringement could prevent us or our collaborators from developing, marketing or selling a product or force us to cease some or all of our business operations. Even if we are successful in these proceedings, we may incur substantial costs and the time and attention of our management and scientific personnel may be diverted as a result of these proceedings, which could have a material adverse effect on us. Claims that we have misappropriated the confidential information or trade secrets of third parties could similarly have a negative impact on our business.

Our success will depend in part on our ability to uphold and enforce patents or patent applications owned or co-owned by us or licensed to us, which cover products we successfully develop. Proceedings involving our patents or patent applications could result in adverse decisions regarding:

- ownership of patents and patent applications;
- rights concerning licenses;
- the patentability of our inventions relating to our products; and/or
- the enforceability, validity or scope of protection offered by our patents relating to our products.

Even if we are successful in these proceedings, we may incur substantial costs and divert management's time and attention in pursuing these proceedings, which could have a material adverse effect on us.

Our results of operations will be affected by the level of royalty payments that we are required to pay to third parties.

We are a party to license agreements that require us to remit royalty payments and other payments related to in-licensed intellectual property. Under our in-license agreements, we may pay up-front fees and milestone payments and be subject to future royalties. We cannot precisely predict the amount, if any, of royalties we will owe in the future, and if our calculations of royalty payments are incorrect, we may owe additional royalties, which could negatively affect our results of operations. As our product sales increase, we may, from time to time, disagree with our third-party collaborators as to the appropriate royalties owed and the resolution of such disputes may be costly and may consume management's time. Furthermore, we may enter into additional license agreements in the future, which may also include royalty, milestone and other payments.

We are subject to governmental export and import controls that could impair our ability to compete in international markets due to licensing requirements and subject us to liability if we are not in compliance with applicable laws.

Our products and products in development are subject to export control and import laws and regulations, including the U.S. Export Administration Regulations, U.S. Customs regulations, and various economic and trade sanctions regulations administered by the U.S. Treasury Department's Office of Foreign Assets Controls. Exports of our products and technology must be made in compliance with these laws and regulations. If we fail to comply with these laws and regulations, we and certain of our employees could be subject to substantial civil or criminal penalties, including the possible loss of export or import privileges; fines, which may be imposed on us and responsible employees or managers; and, in extreme cases, the incarceration of responsible employees or managers.

In addition, changes in our products or solutions or changes in applicable export or import laws and regulations may create delays in the introduction and sale of our products and solutions in international markets, prevent our customers from deploying our products and solutions or, in some cases, prevent the export or import of our products and solutions to certain countries, governments or persons altogether. Any change in export or import laws and regulations, shift in the enforcement or scope of existing laws and regulations, or change in the countries, governments, persons or technologies targeted by such laws and regulations, could also result in decreased use of our products and solutions, or in our decreased ability to export or sell our products and solutions to existing or potential customers. Any decreased use of our products and solutions or limitation on our ability to export or sell our products and solutions would likely adversely affect our business, financial condition and results of operations.

We are subject to anti-corruption and anti-money laundering laws with respect to both our domestic and international operations, and non-compliance with such laws can subject us to criminal and civil liability and harm our business.

We are subject to the U.S. Foreign Corrupt Practices Act of 1977, as amended, the U.S. domestic bribery statute contained in 18 U.S.C. § 201, the U.S. Travel Act, the USA PATRIOT Act, and possibly other anti-bribery and anti-money laundering laws in countries in which we conduct activities. Anti-corruption laws are interpreted broadly and prohibit us and our collaborators from authorizing, offering, or directly or indirectly providing improper payments or benefits to recipients in the public or private sector. We or our collaborators may have direct and indirect interactions with government agencies and state-affiliated entities and universities in the course of our business. We may also have certain matters come before public international organizations such as the United

Nations. We use third-party collaborators, joint venture and strategic partners, law firms, and other representatives for regulatory compliance, patent registration, lobbying, deregulation advocacy, field testing, and other purposes in a variety of countries, including those that are known to present a high corruption risk such as India, China, and Latin American countries. We can be held liable for the corrupt or other illegal activities of these third-party collaborators, our employees, representatives, contractors, partners, and agents, even if we do not explicitly authorize such activities. In addition, although we have implemented policies and procedures to ensure compliance with anti-corruption and related laws, there can be no assurance that all of our employees, representatives, contractors, partners, or agents will comply with these laws at all times. Noncompliance with these laws could subject us to whistleblower complaints, investigations, sanctions, settlements, prosecution, other enforcement actions, disgorgement of profits, significant fines, damages, other civil and criminal penalties or injunctions, suspension and debarment from contracting with certain governments or other persons, the loss of export privileges, reputational harm, adverse media coverage, and other collateral consequences. If any subpoenas or investigations are launched, or governmental or other sanctions are imposed, or if we do not prevail in any possible civil or criminal litigation, our business, results of operations, and financial condition could be materially harmed. In addition, responding to any action will likely result in a materially significant diversion of management's attention and resources and significant defense costs and other professional fees. Enforcement actions and sanctions could further harm our business, results of operations, and financial condition.

Adverse outcomes in future legal proceedings could subject us to substantial damages and adversely affect our results of operations and profitability.

We may become party to legal proceedings, including matters involving personnel and employment issues, personal injury, environmental matters, and other proceedings. Some of these potential proceedings could result in substantial damages or payment awards that exceed our insurance coverage. We will estimate our exposure to any future legal proceedings and establish provisions for the estimated liabilities where it is reasonably possible to estimate and where an adverse outcome is probable. Assessing and predicting the outcome of these matters will involve substantial uncertainties. Furthermore, even if the outcome is ultimately in our favor, our costs associated with such litigation may be material. Adverse outcomes in future legal proceedings or the costs and expenses associated therewith could have an adverse effect on our results of operations.

We may be required to pay substantial damages as a result of product liability claims for which insurance coverage is not available.

We are subject to product liability claims with respect to our SONOVA products, and as additional products integrating our traits reach commercialization, product liability claims will increasingly be a commercial risk for our business, particularly as we are involved in the supply of biotechnological products, some of which may be harmful to humans and the environment. Product liability claims against us or our collaborators selling products that contain our traits, or allegations of product liability relating to seeds containing traits developed by us, could damage our reputation, harm our relationships with our collaborators, and materially and adversely affect our business, results of operations, financial condition, and prospects. Furthermore, while our collaboration agreements typically require that our collaborators indemnify us for the cost of product liability claims brought against us as a result of our collaborator's misconduct, such indemnification provisions may not always be enforced, and we may receive no indemnification if our own misconduct contributed to the claims.

We may seek to expand through acquisitions of and investments in other brands, businesses, and assets. These acquisition activities may be unsuccessful or divert management's attention.

We may consider strategic and complementary acquisitions of and investments in other agricultural biotechnology brands, businesses or other assets, and such acquisitions or investments are subject to risks that could affect our business, including risks related to:

- the necessity of coordinating geographically disparate organizations;
- implementing common systems and controls;
- integrating personnel with diverse business and cultural backgrounds;
- integrating acquired manufacturing and production facilities, technology and products;

- combining different corporate cultures and legal systems;
- unanticipated expenses related to integration, including technical and operational integration;
- increased costs and unanticipated liabilities, including with respect to registration, environmental, health and safety matters, that may affect sales and operating results;
- retaining key employees;
- obtaining required government and third-party approvals;
- legal limitations in new jurisdictions;
- installing effective internal controls and audit procedures;
- issuing common stock that could dilute the interests of our existing stockholders;
- spending cash and incurring debt;
- assuming contingent liabilities; and
- creating additional expenses.

We may not be able to identify opportunities or complete transactions on commercially reasonable terms, or at all, or actually realize any anticipated benefits from such acquisitions or investments. Similarly, we may not be able to obtain financing for acquisitions or investments on attractive terms. In addition, the success of any acquisitions or investments also will depend, in part, on our ability to integrate the acquisition or investment with our existing operations.

We incur significant costs and devote substantial management time as a result of operating as a public company, and our management team has limited experience managing a public company.

As a public company, we incur significant legal, accounting, and other expenses that we did not incur as a private company. For example, we are subject to the reporting requirements of the Securities Exchange Act of 1934, as amended, or the Exchange Act, and are required to comply with the applicable requirements of the Sarbanes-Oxley Act and the Dodd-Frank Wall Street Reform and Consumer Protection Act, as well as rules and regulations subsequently implemented by the SEC and The Nasdaq Stock Market, including the establishment and maintenance of effective disclosure and financial controls and corporate governance practices. Compliance with these requirements has increased and will continue to increase our legal and financial compliance costs and has made and will continue to make some activities more time consuming and costly. Our management and other personnel has had to and will continue to divert attention from operational and other business matters to devote substantial time to these public company requirements, which could adversely affect our business, financial condition, and operating results.

Most members of our management team have limited experience managing a publicly-traded company, interacting with public company investors, and complying with the increasingly complex laws pertaining to public companies. Our management team's inexperience in dealing with these complex laws could be a significant disadvantage to us, because it is likely that an increasing amount of their time will be devoted to these activities, which may result in them spending less time on the management and growth of our company. In addition, our management team may not successfully or efficiently manage being a public company subject to significant regulatory oversight and reporting obligations under the federal securities laws and the continuous scrutiny of securities analysts and investors, which could adversely affect our business, financial condition, and operating results.

As a result of being a public company, we are obligated to develop and maintain proper and effective internal control over financial reporting. We may not complete our analysis of our internal control over financial reporting in a timely manner, or these internal controls may not be determined to be effective, which may adversely affect investor confidence in our company and, as a result, the value of our common stock.

Pursuant to Section 404 of the Sarbanes-Oxley Act and the related rules adopted by the SEC and the Public Company Accounting Oversight Board, starting with the second annual report that we filed with the SEC after the consummation of our public offering, our management is required to report on the effectiveness of our internal control over financial reporting. In addition, once we no longer qualify as an emerging growth company under the JOBS Act and lose the ability to rely on the exemptions related thereto, our independent registered public accounting firm will also need to attest to the effectiveness of our internal control over financial reporting under Section 404. We are starting the process of determining whether our existing internal controls over financial reporting systems are compliant with Section 404. This process will require the investment of substantial time and resources, including by members of our senior management. As a result, this process may divert internal resources and take a significant amount of time and effort to complete. In addition, we cannot predict the outcome of this determination and whether we will need to implement remedial actions in order to implement effective internal control over financial reporting.

In connection with the preparation of our financial statements for the years ended December 31, 2018 and 2017, we identified certain internal control deficiencies that did not rise to the level of a significant deficiency or material weakness, on an individual basis or in the aggregate. We are continuously improving our internal control environment. As a result, we may experience higher than anticipated operating expenses, as well as higher auditor fees during and after the implementation of these changes. If we are unable to implement any of the required changes to our internal control over financial reporting effectively or efficiently or are required to do so earlier than anticipated, it could adversely affect our operations, financial reporting, and results of operations and could result in an adverse opinion on internal controls from our independent registered public accounting firm.

Our ability to use our net operating loss carryforwards to offset future taxable income may be subject to certain limitations.

Under Section 382 of the Internal Revenue Code of 1986, as amended, or the Code, a corporation that undergoes an "ownership change" is subject to limitations on its ability to utilize its NOLs to offset future taxable income. Our existing NOLs may be subject to limitations arising from previous ownership changes, and if we undergo an ownership change in the future, our ability to utilize NOLs could be further limited by Section 382 of the Code. Future changes in our stock ownership, some of which are outside of our control, could result in an ownership change under Section 382 of the Code. Furthermore, our ability to utilize NOLs of companies that we may acquire in the future may be subject to limitations. There is also a risk that, due to regulatory changes, such as suspensions on the use of NOLs, or other unforeseen reasons, our existing NOLs could expire or otherwise be unavailable to offset future income tax liabilities. For these reasons, we may not be able to realize a tax benefit from the use of our NOLs, whether or not we obtain profitability.

Risks Related to our Activities in the Legal Hemp and Cannabis Industries

We will be subject to a myriad of different laws and regulations governing hemp and our inability to comply with such laws in a cost-effective manner may have an adverse effect on our business and result of operations.

Laws and regulations governing the use of hemp in the United States are broad in scope; subject to evolving interpretations; and subject to enforcement by a myriad of regulatory agencies and law enforcement entities. Under the Agriculture Improvement Act of 2018, also known as the 2018 Farm Bill, a state or Indian tribe that desires to have primary regulatory authority over the production of hemp in the state or territory of the Indian tribe must submit a plan to monitor and regulate hemp production to the Secretary of the United States Department of Agriculture or USDA. The Secretary must then approve the state or tribal plan after determining if the plan complies with the requirements set forth in the Agriculture Improvement Act of 2018. The Secretary may also audit the state or Indian tribe's compliance with the federally-approved plan. If the Secretary does not approve the state or Indian tribe's plan, then the production of hemp in that state or territory of that Indian tribe will be subject to a plan established by USDA. USDA has not yet established such a plan. We anticipate that many states will seek to have primary regulatory authority over the production of hemp. States that seek such authority may create new laws and regulations that limit or restrict the use of hemp.

Federal and state laws and regulations on hemp may address production, monitoring, manufacturing, distribution, and laboratory testing to ensure that that the hemp has a delta-9 tetrahydrocannabinol concentration of not more than 0.3 percent on a dry weight basis. Federal laws and regulations may also address the transportation or shipment of hemp or hemp products, as the Agriculture Improvement Act of 2018 prohibits states and Indian tribes from prohibiting the transportation or shipment of hemp or hemp products produced in accordance with that law through the state or territory of the Indian tribe, as applicable. We may be subject to many different state-based regulatory regimens for hemp, all of which could require us to incur substantial costs associated with compliance requirements. Our research and development operations will be restricted to only where such operations are legal on the local, state and federal levels.

In addition, it is possible that additional regulations may be enacted in the future in the United States and globally that will be directly applicable to our research and development operations. We cannot predict the nature of any future laws, regulations, interpretations, or applications, nor can we determine what effect additional governmental regulations or administrative policies and procedures, when and if promulgated, could have on our business.

We have no operating history in the legal hemp or cannabis industry, which makes it difficult to accurately assess our future growth prospects.

The legal hemp and cannabis industry is an evolving industry that may not develop as expected. Furthermore, our operations continue to evolve as we continually assess new strategic opportunities for our business within this industry. Assessing the future prospects of this industry is challenging in light of both known and unknown risks and difficulties we may encounter. Growth prospects in the legal hemp and cannabis industry can be affected by a wide variety of factors including:

- Competition from other similar companies;
- Regulatory limitations on the types of research and development with respect to cannabis;
- Other changes in the regulation of cannabis and legal hemp use; and
- Changes in underlying consumer behavior, which may affect the demand of our legal hemp and cannabis traits.

We may not be able to successfully address the above factors, which could negatively impact our intended business plans.

Because we have only recently begun our legal hemp operations, we anticipate our operating expenses will increase prior to earning revenue from these operations:

As we start to conduct research and development with respect to legal hemp, we anticipate significant increases in our operating expenses, without realizing significant revenues from such operations. As a result, the Company may incur significant financial losses with respect to such operations in the foreseeable future. There is no history upon which to base any assumption as to the likelihood that these operations will prove successful.

Negative press from being in the hemp/cannabis space could have a material adverse effect on our business, financial condition, and results of operations.

The hemp plant and the cannabis/marijuana plant are both part of the same *cannabis sativa* genus/species of plant, except that hemp, by definition, has less than 0.3% THC content, but the same plant with a higher THC content is cannabis/marijuana, which is legal under certain state laws, but which is not legal under federal law. The similarities between these plants can cause confusion, and our activities with legal hemp may be incorrectly perceived as us being involved in federally illegal cannabis. Also, despite growing support for the cannabis industry and legalization of cannabis in certain U.S. states, many individuals and businesses remain opposed to the cannabis industry. Any negative press resulting from any incorrect perception that we have entered into the cannabis space could result in a loss of current or future business. It could also adversely affect the public's perception of us and lead to reluctance by new parties to do business with us or to own our common stock. We cannot assure you that additional business partners, including but not limited to financial institutions and customers, will not attempt to end or curtail their relationships with us. Any such negative press or cessation of business could have a material adverse effect on our business, financial condition, and results of operations.

Risks Related to Ownership of Our Common Stock

Sales of a substantial number of shares of our common stock in the public market, or the perception that these sales might occur, could cause our stock price to decline.

Sales of a substantial number of our common stock in the public market, or the perception that these sales might occur, could cause the market price of our common stock to decline and could impair our ability to raise capital through the sale of additional equity securities. As of December 31, 2018, there were 4,774,919 shares of our common stock outstanding, of which approximately 2,949,506 shares were held by non-affiliates. All of our common stock is freely transferable, except shares held by our "affiliates," as defined in Rule 144 under the Securities Act.

We may also issue common stock or options to purchase shares of our common stock that under our 2015 Omnibus Equity Incentive Plan and our 2015 Employee Stock Purchase Plan. Securities issued under these plans will be registered under a Form S-8 and are freely tradable upon issuance. There were 183,300 options exercisable as of December 31, 2018 at a weighted average exercise price of $71.47.

Our stock price has been and may continue to be volatile, and you could lose all or part of your investment.

The market price of our common stock since our initial public offering has been and may continue to be volatile. Since shares of our common stock were sold in our initial public offering in May 2015 at a price of $160.00 per share, our stock price has ranged from $2.65 to $176.00, through December 31, 2018. The market price of our common stock is subject to wide fluctuations in response to various risk factors, some of which are beyond our control and may not be related to our operating performance, including:

- addition or loss of significant customers, collaborators or distributors;
- changes in laws or regulations applicable to our industry or traits;
- additions or departures of key personnel;
- the failure of securities analysts to cover our common stock after this offering;
- actual or anticipated changes in expectations regarding our performance by investors or securities analysts;
- price and volume fluctuations in the overall stock market;
- volatility in the market price and trading volume of companies in our industry or companies that investors consider comparable;
- share price and volume fluctuations attributable to inconsistent trading volume levels of our shares;
- our ability to protect our intellectual property and other proprietary rights;
- sales of our common stock by us or our stockholders;
- the expiration of contractual lock-up agreements;
- litigation involving us, our industry, or both;
- major catastrophic events; and
- general economic and market conditions and trends.

Further, the stock markets have experienced extreme price and volume fluctuations that have affected and continue to affect the market prices of equity securities of many companies. These fluctuations often have been unrelated or disproportionate to the operating performance of those companies. In addition, the stock prices of many seed and agricultural biotechnology companies have experienced wide fluctuations that have often been unrelated to the operating performance of those companies. These broad market and industry fluctuations, as well as general economic, political, and market conditions such as recessions, interest rate changes, or international currency fluctuations, may cause the market price of our common stock to decline. If the market price of our common stock fluctuates or declines, you may not realize any return on your investment and may lose some or all of your investment.

Insiders have substantial control over us, which could limit your ability to influence the outcome of key transactions, including a change of control.

Our executive officers, directors, and three largest stockholders, in the aggregate, beneficially own approximately 38% of the outstanding shares of our common stock as of December 31, 2018. As a result, these stockholders, if acting together, would be able to influence matters requiring approval by our stockholders, including the election of directors and the approval of mergers, acquisitions or other extraordinary transactions. They may have interests that differ from yours and may vote in a way with which you disagree and that may be adverse to your interests. This concentration of ownership may have the effect of delaying, preventing or deterring a change of control of our company, could deprive our stockholders of an opportunity to receive a premium for their common stock as part of a sale of our company and might affect the market price of our common stock.

We expect our operating results to vary significantly from quarter to quarter, which may cause our stock price to fluctuate widely.

We expect our quarterly operating results to fluctuate widely and unpredictably for the following reasons, among others:

- our significant customer concentration;
- our uncertain ability to obtain government grant funding, which affects the timing and amounts of our payments from the U.S. government;
- the variable timing, stage, and results of our and our collaborators' research, development, and regulatory activities;
- the impact of seasonality in agricultural operations on our field trials and sales of products that incorporate our seed traits;
- supplier, manufacturing, or quality problems; and
- variance in the timing of customer and distributor orders for our SONOVA products.

Further, a large proportion of our costs are fixed, due in part to our significant research and development costs and general and administrative expenses. Thus, even a small decline in revenues could disproportionately affect our quarterly operating results and could cause such results to differ materially from expectations. Any unanticipated change in revenues or operating results is likely to cause our stock price to fluctuate since such changes reflect new information available to investors and analysts.

Provisions in our amended and restated certificate of incorporation and amended and restated bylaws might discourage, delay or prevent a change of control of our company or changes in our management and, therefore, depress the trading price of our common stock.

Our amended and restated certificate of incorporation and amended and restated bylaws contain provisions that could depress the trading price of our common stock by discouraging, delaying or preventing a change of control of our company or changes in our management that the stockholders of our company may believe advantageous. These provisions include:

- establishing a classified board of directors so that not all members of our board of directors are elected at one time;
- authorizing "blank check" preferred stock that our board of directors could issue to increase the number of outstanding shares to discourage a takeover attempt;
- eliminating the ability of stockholders to call a special stockholder meeting;
- eliminating the ability of stockholders to act by written consent;
- the requirement that, to the fullest extent permitted by law and unless we consent to an alternate form, certain proceedings against or involving us or our directors, officers, or employees be brought exclusively in the Court of Chancery in the State of Delaware;

- providing that the board of directors is expressly authorized to make, alter, or repeal our bylaws; and
- establishing advance notice requirements for nominations for elections to our board of directors or for proposing matters that can be acted upon by stockholders at stockholder meetings.

If securities or industry analysts do not publish or cease publishing research or reports about us, our business, or our market, or if they change their recommendations regarding our stock adversely, our stock price and trading volume could decline.

The trading market for our common stock is influenced by the research and reports that industry or securities analysts may publish about us, our business, our market or our competitors. If any of the analysts who may cover us make adverse changes to their recommendation regarding our stock, or provide more favorable relative recommendations about our competitors, our stock price would likely decline. If any analyst who may cover us were to cease coverage of our company or fail to regularly publish reports on us, we could lose visibility in the financial markets, which in turn could cause our stock price or trading volume to decline.

As an emerging growth company within the meaning of the Securities Act, we utilize certain modified disclosure requirements, and we cannot be certain if these reduced requirements will make our common stock less attractive to investors.

We are an emerging growth company within the meaning of the rules under the Securities Act and we plan in future filings with the SEC to utilize, the modified disclosure requirements available to emerging growth companies, including reduced disclosure about our executive compensation and omission of compensation discussion and analysis, and an exemption from the requirement of holding a nonbinding advisory vote on executive compensation. In addition, we are not subject to certain requirements of Section 404 of the Sarbanes-Oxley Act, including the additional testing of our internal control over financial reporting as may occur when outside auditors attest as to our internal control over financial reporting. As a result, our stockholders may not have access to certain information they may deem important. We cannot predict if investors will find our common stock less attractive because we rely on these exemptions. If some investors find our common stock less attractive as a result, there may be a less active trading market for our common stock and our stock price may be more volatile.

We could remain an emerging growth company for up to five years, or until the earliest of (i) the last day of the first fiscal year in which our annual gross revenues exceed $1.0 billion, (ii) the date that we become a large accelerated filer as defined in Rule 12b-2 under the Exchange Act, which would occur if the market value of our common stock that is held by non-affiliates exceeds $700 million as of the last business day of our most recently completed second fiscal quarter, or (iii) the date on which we have issued more than $1.0 billion in non-convertible debt during the preceding three-year period.

Because we do not expect to pay any dividends for the foreseeable future, investors may be forced to sell their stock to realize a return on their investment.

We do not anticipate that we will pay any dividends to holders of our common stock for the foreseeable future. Any payment of cash dividends will be at the discretion of our board of directors and will depend on, among other things, our results of operations, cash requirements, financial condition, contractual restrictions including compliance with covenants under our debt agreements, and other factors that our board of directors may deem relevant. Our ability to pay dividends might be restricted by the terms of any indebtedness that we incur in the future. In addition, certain of our current outstanding debt agreements prohibit us from paying cash dividends on our common stock. Consequently, you should not rely on dividends to receive a return on your investment.

Our common stock may be delisted from The Nasdaq Capital Market if we are unable to maintain compliance with Nasdaq's continued listing standards.

As a company traded on The Nasdaq Capital Market, we are subject to compliance with The Nasdaq Stock Market's rules and requirements, which require, among other things, that our minimum bid price be $1.00 or higher and minimum shareholders' equity be $2.5 million or higher. In the event we do not meet the Nasdaq listing criteria for 30 consecutive days, Nasdaq will send a "deficiency notice" to inform the company that it will be delisted after 180 calendar days unless it meets the requirements.

On February 14, 2017, we received a letter from Nasdaq notifying us that we were not in compliance with the minimum closing bid requirement set forth in Nasdaq Listing Rule 5405. In accordance with Nasdaq Listing Rule 5450(a)(1), we were required to regain compliance with the minimum closing bid requirement by August 14, 2017.

On July 21, 2017, the Company transferred the listing of its common stock to The Nasdaq Capital Market (the "Capital Market"), and as a result, the Company was afforded the remainder of the 180-day period, or until August 14, 2017, to regain compliance with the minimum $1 bid price per share requirement. As of August 14, 2017, we were still not in compliance with the minimum $1 bid price per share requirement. However, Nasdaq determined that the Company had until February 12, 2018 to regain compliance with the minimum bid price requirement.

On February 7, 2018, we received a letter from Nasdaq notifying us that the Company has regained compliance with Listing Rule 5450(a)(1) and this matter is now closed.

On March 4, 2019, we received a letter from Nasdaq requesting information related to the establishment of Arcadia Specialty Genomics™ announced on February 28, 2019.

In the event we are delisted from the Nasdaq Capital Market, we would be forced to list our shares on the OTC Electronic Bulletin Board or some other quotation medium, such as the pink sheets, depending on our ability to meet the specific listing requirements of those quotation systems. As a result, an investor might find it more difficult to trade or to obtain accurate price quotations for such shares.

Any delisting of our common stock could adversely affect the market liquidity of our common stock and the market price of our common stock could decrease and/or become more volatile. Furthermore, if our common stock were delisted, it could adversely affect our ability to obtain additional financing and/or result in the loss of confidence by investors, collaborators and other third parties, customers, and employees.

Item 1B. Unresolved Staff Comments.

Not applicable.

Item 2. Properties.

Our corporate headquarters are located in Davis, California, in a facility consisting of approximately 16,280 square feet of office, laboratory and growth chamber space under a lease that expires on July 31, 2023. This facility accommodates research and development, operations, analytical services, regulatory and administrative activities. Our administrative offices in Phoenix, Arizona, consist of 2,976 square feet under a lease that expires on December 31, 2021. The Phoenix office accommodates our finance, legal and other administrative activities, as well as sales and marketing activities for our SONOVA products. We lease greenhouse space and farm land for agricultural use in Northern California as well as farmland in Idaho. We also lease office and warehouse space in Idaho under a lease that expires on December 31, 2021. Our Seattle research location closed in March 2017.

We believe that our leased facilities are adequate to meet our current needs and that, if needed, suitable additional or alternative space will be available to accommodate our operations.

Item 3. Legal Proceedings.

Except as set forth below, we currently are not a party to any material litigation or other material legal proceedings. From time to time, we may be subject to legal proceedings and claims in the ordinary course of business.

In February 2018, we initiated an interference proceeding with the United States Patent and Trademark Office (USPTO) concerning a patent application owned by us and a patent owned by Arista Cereals Technologies Pty Limited relating to our Resistant Starch Wheat products to determine priority of invention. On August 14, 2018, the USPTO issued a decision that resulted in termination of the interference which we have since appealed. A decision on the appeal is not expected until the latter half of 2019. If we lose the appeal, the interference is finally terminated and Arista maintains its patent. If we win the appeal, the interference resumes at the USPTO. The USPTO may determine we were the first to invent, in which case the subject matter of the interference count may be granted in a patent to us. Or, the USPTO may determine Arista was the first to invent, in which case Arista may maintain its patent. A ruling by the USPTO in favor of Arista would not affect our current patent(s), nor would it preclude us from commercializing our Resistant Starch Wheat product.

On September 4, 2018, we filed a Complaint against Vilmorin & Cie, Limagrain Ceréales Ingredients, SA, and Arista Cereal Technologies Pty Limited in the United States District Court for the Southern District of New York, Case No. 18-cv-8059, asserting claims for correction of inventorship, breach of contract, breach of the implied covenant of good faith and fair dealing, unfair competition, misappropriation of confidential information, unjust enrichment, conversion, and tortious interference, based on the Defendants' asserted misappropriation and misuse of an invention first conceived and reduced to practice by us. On October 26, 2018, we filed a First Amended Complaint asserting additional factual allegations but substantially similar causes of action. The Defendants filed motions to dismiss the First Amended Complaint. On January 11, 2019, the Court dismissed the claims against Defendant Arista Cereal Technologies Pty Ltd without prejudice based on lack of personal jurisdiction and dismissed the claims against the other Defendants with prejudice. Defendants asserted no counterclaims against us in the action. This case is now closed.

Item 4. Mine Safety Disclosures.

Not applicable.

PART II

Item 5. Market for Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities.

Our common stock has been listed on the NASDAQ Stock Market under the symbol "RKDA" since May 15, 2015. Prior to May 15, 2015, there was no public trading for our common stock. The following table sets forth for the periods indicated the high and low sales price per share of our common stock as reported on the NASDAQ Stock Market:

YEAR ENDED DECEMBER 31, 2017	HIGH	LOW
First Quarter	$ 23.60	$ 13.00
Second Quarter	$ 17.00	$ 8.40
Third Quarter	$ 15.60	$ 6.00
Fourth Quarter	$ 9.80	$ 3.60

YEAR ENDED DECEMBER 31, 2018	HIGH	LOW
First Quarter	$ 66.56	$ 4.10
Second Quarter	$ 32.28	$ 7.31
Third Quarter	$ 8.44	$ 4.46
Fourth Quarter	$ 5.76	$ 2.65

Holders of Record

As of March 7, 2019, we had 39 holders of record of our common stock. Because many of our shares of common stock are held by brokers and other institutions on behalf of stockholders, we are unable to estimate the total number of beneficial stockholders represented by these record holders.

Dividend Policy

We have never declared or paid cash dividends on our capital stock. We currently intend to retain all available funds and any future earnings for use in the operation of our business and do not anticipate paying any cash dividends in the foreseeable future. Any decision to declare and pay cash dividends in the future will be made at the discretion of our board of directors and will depend on, among other things, our results of operations, cash requirements, financial condition, contractual restrictions, and other factors that our board of directors may deem relevant.

Recent Sales of Unregistered Securities

None.

Purchases of Equity Securities by the Issuer and Affiliated Purchasers

We did not repurchase any of our equity securities during the year ended December 31, 2018.

Item 6. Selected Financial Data.

The following selected Consolidated Statements of Operations and Comprehensive Loss data for the years ended December 31, 2018 and 2017 and the Consolidated Balance Sheets data as of December 31, 2018 and 2017 are derived from our audited consolidated financial statements included herein, and should be read together with our consolidated financial statements, the notes to our consolidated financial statements and "Management's Discussion and Analysis of Financial Condition and Results of Operations."

	Year Ended December 31,	
	2018	2017
	(in thousands, except share and per share amounts)	
Revenues:		
Product	$ 657	$ 514
License	150	1,470
Contract research and government grants	657	2,042
Total revenues	1,464	4,026
Operating expenses:		
Cost of product revenues	661	283
Research and development(1)	6,069	7,407
Selling, general, and administrative(1)	11,604	10,651
Total operating expenses	18,334	18,341
Loss from operations	(16,870)	(14,315)
Interest expense	—	(747)
Other income, net	394	281
Initial loss on common stock warrant and common stock adjustment feature liabilities	(4,000)	—
Change in fair value of common stock warrant and common stock adjustment feature liabilities	9,561	—
Offering costs	(2,555)	—
Loss on extinguishment of debt	—	(900)
Loss before income taxes	(13,470)	(15,681)
Income tax provision	(10)	(26)
Net loss attributable to common stockholders	(13,480)	(15,707)
Net loss per share attributable to common stockholders, basic and diluted(2)	$ (3.58)	$ (7.28)
Weighted-average number of shares used in per share calculations, basic and diluted(2)	3,766,419	2,156,201

(1) Includes stock-based compensation expense as follows:

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Research and development	$ 379	$ 411
Selling, general, and administrative	1,171	1,063
Total stock-based compensation	$ 1,550	$ 1,474

(2) See Note 18 of the notes to our consolidated financial statements for a description of how we compute net loss per share attributable to common stockholders, basic and diluted, and pro forma net loss per share attributable to common stockholders, basic and diluted.

	As of December 31,	
	2018	2017
	(in thousands)	
Consolidated Balance Sheets Data:		
Cash and cash equivalents	$ 11,998	$ 9,125
Working capital	19,822	11,522
Total assets	24,024	16,570
Additional paid-in capital	191,136	175,223
Accumulated deficit	(178,366)	(167,257)
Total stockholder's equity	12,815	8,007

Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations.

Special Note Regarding Forward-Looking Statements

The following discussion and analysis of our financial condition and results of operations should be read in conjunction with our audited consolidated financial statements and the related notes to those statements included herein. In addition to historical financial information, this report contains forward-looking statements that involve risks and uncertainties. Our actual results could differ materially from those discussed in the forward-looking statements. The statements contained in this report that are not purely historical are forward-looking statements within the meaning of Section 27A of the Securities Act and Section 21E of the Securities Exchange Act of 1934, as amended, or the Exchange Act. Forward-looking statements are often identified by the use of words such as, but not limited to, "anticipate," "believe," "can," "continue," "could," "estimate," "expect," "intend," "may," "plan," "project," "seek," "should," "strategy," "target," "will," "would" and similar expressions or variations intended to identify forward-looking statements. These statements are based on the beliefs and assumptions of our management based on information currently available to management. Such forward-looking statements are subject to risks, uncertainties and other important factors that could cause actual results and the timing of certain events to differ materially from future results expressed or implied by such forward-looking statements. Factors that could cause or contribute to such differences include, but are not limited to, those identified below. Furthermore, such forward-looking statements speak only as of the date of this report. Except as required by law, we undertake no obligation to update any forward-looking statements to reflect events or circumstances after the date of such statements.

"Arcadia Biosciences," "Sonova" and "Sonova GLA Safflower Oil and design" are our registered trademarks in the United States and, in some cases, in certain other countries. This report may also contain trademarks, service marks, and trade names of other companies. Solely for convenience, the trademarks, service marks and trade names referred to in this report may appear without the ®, TM, or SM symbols, but such references do not constitute a waiver of any rights that might be associated with the respective trademarks, service marks, or trade names.

Overview

We are a consumer-driven, agricultural food ingredient company. We aim to create value across the agricultural production and supply chain beginning with enhanced crop productivity for farmers and ultimately delivering accelerated innovation in nutritional quality foods to consumers. We use state of the art gene-editing technology and advanced breeding techniques to naturally enhance the nutritional quality of grains and oilseeds to address the rapidly evolving trends in consumer health and nutrition. In addition, we have developed a broad pipeline of high value crop productivity traits designed to enhance farm economics.

Consumers are demanding food companies provide healthier, high quality foods, naturally and sustainably produced with greater ingredient simplicity and transparency. Now, more than ever, consumers are paying premium pricing to satisfy their dietary health requirements, such as higher fiber and lower gluten in grains, healthier oils and fewer processed ingredients. Consumer food companies recognize this shift but cannot rely upon the legacy ag-supply chain and traditional crop breeding techniques to meet these demands. Conventional and transgenic breeding processes can take between nine and 13 years to bring new food varieties or quality traits to market, causing consumer food companies to search for alternative means to satisfy the evolving customer demands. The need for rapid product differentiation at the consumer level has opened up a premium food market opportunity that is becoming one of the fastest growing segments in the food industry.

To address this large and growing demand, we are building on our industry leading scientific expertise and advanced plant breeding and transformation technologies developed over the past 15 years, to directly edit the plant genome without introducing foreign DNA, to produce nutrient-dense crops for use in the major foods we eat. By employing gene editing technology and our TILLING platform, we believe we can reduce the time to market for novel ingredient traits by half, thereby providing consumer food companies a steady and reliable source of cost effective, healthy natural food options.

In 2018, we launched our GoodWheat™ brand, a non-transgenic (non-GM) portfolio of wheat products that enables food manufacturers to differentiate their consumer-facing brands. The brand launch is a key element of the company's go-to-market strategy to achieve greater value for its innovations by participating in downstream consumer revenue opportunities. Arcadia designed the brand to make an immediate connection with consumers that products made with GoodWheat™ meet their demands for healthier wheat options that also taste great. The GoodWheat™ brand encompasses Arcadia's current and future non-GM wheat portfolio of high fiber Resistant Starch (RS) and Reduced Gluten wheat varieties, as well as future wheat innovations. In October 2018, the U.S. Patent and Trademark Office has granted Arcadia a patent for extended shelf life wheat, the newest trait in our non-genetically modified (non-GM) GoodWheat™ portfolio. This new trait was designed to promote whole wheat consumption by improving the shelf life and taste of whole grain wheat products.

We expect to market GoodWheat™ products in 2019. Increased fiber consumption is well recognized as a way to improve gut health and to control excessive weight gain. Concurrently, we are developing three additional wheat varieties, a reduced gluten wheat, an extended shelf life wheat and a superior yielding wheat. In the American diet, each day more than 500 calories come from wheat products, 25 percent of the FDA's recommended daily caloric intake for a woman and 20 percent for a man. We believe these varieties have broad application in the global wheat market which is estimated by the USDA (US Department of Agriculture) to be 758 million metric tons, which roughly equates to $208 billion farm gate value (i.e. market value net of selling costs).

In years to come, we expect to achieve enhanced nutritional characteristics within a number of other broad acre crops using advanced breeding and gene-editing techniques. Targets include but are not limited to higher fiber, longer shelf life and enhanced protein in crops other than wheat.

Another aspect of our business is improving farmer productivity through the development of more robust crop varieties, by developing specific crop traits designed to counteract the detrimental impact of environmental stresses on harvest yields. Traditional genetic modification (GM) trait development has concentrated on crops where the combination of large acreage and high input costs (such as chemical costs for pest and weed control) create significant economic value for herbicidal or insecticidal traits. However, far more deleterious to crop yields are abiotic stresses, such as drought, heat, nutrient deficiency, water scarcity, and soil salinity, and remains largely unpenetrated by the GM seed industry today. For example, industry estimates indicate greater than 80 percent of wheat yield loss and 65 percent of corn yield loss globally are lost due to abiotic factors. These stresses are prevalent in most agricultural environments with varying degrees of severity and often have material consequences on crop production, quality, and farmers' incomes.

We devoted much of our early research to building a comprehensive array of abiotic stress traits. Furthermore, through out-licensing arrangements with our commercialization partners, many of our traits have been bred into several global crops, including rice, wheat, and soybeans, and we have demonstrated significant yield improvements in multiple years of field testing. However, due to the global variability in acceptance of GM traits from one territory to the next, the commercial timing and ultimate value of these innovations is difficult to predict.

Regardless of the timing and degree of commercial success of our historical transgenic traits, the technical achievements they represent has established the company as a world-class plant transformation organization.

Balancing our near-term revenue goals with long-term value capture, we will continue to provide active support to our commercial partners working to advance our high value traits through development and deregulation for commercialization.

While we seek patent protection on our technologies and traits, we have structured our commercial agreements so that we receive our percentage of additional commercial value whether or not patent protection is in effect at any particular time or place. Nearly all of our agreements provide access to our traits, and our right to receive a share of commercial value, continue for a set number of years after products containing our traits are commercialized. While the exclusive rights afforded by patents may enable our commercial partners to realize greater commercial value attributable to our traits, our right to receive a portion of that increased commercial value is not dependent on the existence of patent rights in a particular geography.

Our commercial strategy is to migrate forward in the ag-food supply chain from the farmer and seed company to the consumer food company. Due to early stage focus on the development of abiotic stress traits, we have historically been commercially aligned with farmers and seed companies. However, by also establishing commercial relationships with consumer food companies and developing consumer brand awareness of our high value premium ingredients, we expect to be better positioned to garner a greater share of our product's value proposition. Consumer food companies are looking to simplify their food ingredient formulations and consumer are demanding "clean labeling" in their foods, paying more for foods having fewer artificial ingredients and more natural, recognizable and healthy ingredients. In 2015, the Food Business News cited ninety-one percent of U.S. consumers believe food and beverage options with recognizable ingredients are healthier. Because we increase nutrient density directly in the primary grains and oils, we provide the mechanism for food formulation simplification naturally, cost effectively and in a time-frame to meet evolving consumer demands. Our branding strategy is to link consumer's health and nutrition appreciation with the nutrients we source directly from the farm, enabling us to share premium economics throughout the ag-food supply chain.

This forward migration in the ag-food supply chain will require that we build additional organizational capabilities and industry expertise. For instance, we are expanding our in-house commercial grain production and logistics resources for greater scale capacity to bring our products to market. We are also developing product branding strategies to build customer brand recognition and loyalty.

Arcadia Specialty Genomics™

In February 2019, we announced the establishment of Arcadia Specialty Genomics™ ("ASG") a new strategic business unit dedicated to developing and commercializing genetic improvements targeting plant content, quality, climate resiliency and overall yield in cannabis, a new crop for the company. ASG intends to conduct its business in only federal and state markets in which its activities are legal.

The recent passage of the U.S. Agriculture Improvement Act of 2018 – also known as the Farm Bill – confirmed the federal legalization of hemp, the term given to non-psychoactive cannabis containing less than 0.3% tetrahydrocannabinol (THC). It also included provisions for legalizing on a federal level hemp's cultivation, transport and sale for the first time in more than 75 years. Hemp, previously considered a Schedule 1 drug and banned as an agricultural crop, lacks substantive plant biology research and suffers from suboptimal genetics, highly fragmented germplasm and rampant inconsistencies. As with our wheat and soybean products, we plan to create hemp-based solutions that allow farmers to be more productive and enable consumer packaged goods companies to differentiate their brands in the marketplace. In the near term, our focus will be on acquiring federal and state licensure in key geographies to launch our research and pilot programs, for which we expect to begin operations in early 2019. In parallel, we are evaluating key partnerships to extend our capabilities vertically to maximize the value creation potential of our innovations.

The Hemp Business Journal estimates the hemp CBD market – the primary non-psychoactive compound in cannabis – totaled $190 million in 2018. By 2022, the Brightfield Group, a cannabis and CBD market research firm, projects sales to reach $22 billion.

Since our inception, we have devoted substantially all our efforts to research and development activities, including the discovery, development, and testing of our traits and products in development incorporating our traits. To date, we have not generated revenues from sales of commercial products, other than limited revenues from our SONOVA products. We do receive revenues from fees associated with the licensing of our traits to commercial partners. Our long-term business plan and growth strategy is based in part on our expectation that revenues from products that incorporate our traits will comprise a significant portion of our future revenues.

We have never been profitable and had an accumulated deficit of $178.4 million as of December 31, 2018. We incurred net losses of $13.5 million and $15.7 million for the years ended December 31, 2018 and 2017, respectively. We expect to incur substantial costs and expenses before we obtain any revenues from the sale of seeds incorporating our traits. As a result, our losses in future periods could become even more significant, and we will need additional funding to support our operating activities.

Components of Our Statements of Operations Data

Revenues

We derive our revenues from product revenues, licensing agreements, contract research agreements, and government grants. Given our acute focus on the near-term commercialization of our nutritional ingredient traits and products, we do not intend to continue pursuing contract research agreements and government grant projects at the levels we have historically. Over the next nine to 18 months, we expect these revenues to decline as our current contract research agreements and government grant projects conclude and not replaced. Concurrently, as we introduce our new nutritional ingredient traits and products to the market, we expect revenues to increase from such activities. Furthermore, with the implementation of Accounting Standards Codification (ASC) Topic 606, as described more fully in Note 6, future license revenues no longer include the amortization of deferred up-front license fees from existing license agreements.

Product Revenues

Our product revenues to date have consisted solely of sales of our SONOVA products. We generally recognize revenue from product sales upon sale to our third-party distributors or customers. Our revenues fluctuate depending on the timing of orders from our customers and distributors.

License Revenues

Our license revenues to date consist of up-front, nonrefundable license fees, annual license fees, and subsequent milestone payments that we receive under our research and license agreements.

Milestone fees are a variable consideration that is initially constrained and recognized only when it is probable that such amounts would not be reversed. Given the seasonality of agriculture and time required to progress from one milestone to the next, achievement of milestones is inherently uneven, and our license revenues are likely to fluctuate significantly from period to period.

Contract Research and Government Grant Revenues

Contract research and government grant revenues consist of amounts earned from performing contracted research primarily related to breeding programs or the genetic engineering of plants for third parties. We also receive payments from government entities in the form of government grants.

Operating Expenses

Cost of Product Revenues

Cost of product revenues relates to the sale of our SONOVA products and consists of in-licensing and royalty fees, any adjustments or write-downs to inventory, as well as the cost of raw materials, including inventory and third-party services costs related to procuring, processing, formulating, packaging, and shipping our SONOVA products.

Research and Development Expenses

Research and development expenses consist of costs incurred in the discovery, development, and testing of our products and products in development incorporating our traits. These expenses consist primarily of employee salaries and benefits, fees paid to subcontracted research providers, fees associated with in-licensing technology, land leased for field trials, chemicals and supplies, and other external expenses. These costs are expensed as incurred. Additionally, we are required from time to time to make certain milestone payments in connection with the development of technologies in-licensed from third parties. Our research and development expenses may fluctuate from period to period as a result of the timing of various research and development projects.

Selling, General, and Administrative Expenses

Selling, general, and administrative expenses consist primarily of employee costs, professional service fees, and overhead costs. Our selling, general, and administrative expenses may fluctuate from period to period. In connection with our commercialization activities for our consumer ingredient products, we expect to increase our investments in sales and marketing and business development.

Interest Expense

Interest expense consists primarily of contractual interest and amortization of debt discount on our term loan that was repaid in July 2017.

Other Income, Net

Other income, net, consists of interest income and the amortization of investment premium and discount on our cash and cash equivalents and investments.

Initial Loss on Common Stock Warrant and Common Stock Adjustment Feature Liabilities

Initial loss on common stock warrant and common stock adjustment feature liabilities is comprised of the loss associated with the initial recognition of the common stock warrant and common stock adjustment feature liabilities associated with the Private Placement in March 2018 at their respective fair values.

Change in the Estimated Fair Value of Common Stock Warrant Liabilities and Common Stock Adjustment Feature Liability

Change in the estimated fair value of common stock warrant liabilities and common stock adjustment feature liability is comprised of the fair value remeasurement of the liabilities associated with the March Private Placement and the June Private Placement.

Offering Costs

Offering costs consists of the costs incurred with the issuance of common stock and common stock warrants in connection with the Private Placement. Also included are costs incurred with the June Offering and June Private Placement that have been allocated to the common stock warrant liability. Costs include placement agent, legal, advisory, accounting and filing fees.

Income Tax Provision

Our income tax provision has not been historically significant, as we have incurred losses since our inception. The provision for income taxes consists of state and foreign income taxes. Due to cumulative losses, we maintain a valuation allowance against our U.S. deferred tax assets as of December 31, 2018 and 2017. We consider all available evidence, both positive and negative, including but not limited to, earnings history, projected future outcomes, industry and market trends and the nature of each of the deferred tax assets in assessing the extent to which a valuation allowance should be applied against our U.S. deferred tax assets.

Results of Operations

Comparison of the Years Ended December 31, 2018 and 2017

	Year Ended December 31,	
	2018	2017
	(in thousands)	
Revenues:		
Product	$ 657	$ 514
License	150	1,470
Contract research and government grants	657	2,042
Total revenues	1,464	4,026
Operating expenses:		
Cost of product revenues	661	283
Research and development	6,069	7,407
Selling, general and administrative	11,604	10,651
Total operating expenses	18,334	18,341
Loss from operations	(16,870)	(14,315)
Interest expense	—	(747)
Other income, net	394	281
Initial loss on common stock warrant and common stock adjustment feature liabilities	(4,000)	—
Change in fair value of common stock warrant and common stock adjustment feature liabilities	9,561	—
Offering costs	(2,555)	—
Loss on extinguishment of debt	—	(900)
Loss before income taxes	(13,470)	(15,681)
Income tax provision	(10)	(26)
Net loss attributable to common stockholders	$ (13,480)	$ (15,707)

Revenues

Product revenues accounted for 45% and 13% of our total revenues for the years ended December 31, 2018 and 2017, respectively. The $143,000, or 28%, increase in product revenues from sales of our SONOVA products was primarily driven by additional encapsulated orders.

License revenues accounted for 10% and 37% of our total revenues for the years ended December 31, 2018 and 2017, respectively. The $1.3 million, or 90%, decrease in license revenue was due, in part, to the termination of several agreements in 2017 that resulted in the recognition of previously deferred upfront license fees at the end of 2017. The Company adopted ASC Topic 606 on January 1, 2018 and, as a result, revenue recognized in 2017 for the amortization of up-front license fees previously collected and amortized over the entire commercial development timeline is not present in 2018 as up-front fees are currently recognized upon agreement execution under the new guidance. There were no license agreements executed in 2018.

Contract research and government grant revenues accounted for 45% and 51% of our total revenues for the years ended December 31, 2018 and 2017, respectively. The $1.4 million, or 68%, decrease in contract research and government grant revenues was primarily driven by the completion of agreements and grants, as well as less activity for existing grants. Contract research and government grant revenues can vary from year-to-year depending on the timing of contract research projects and the completion of services provided, and the timing of eligible research and development expenses. Given our acute focus on the near-term commercialization of our nutritional ingredient traits and products, we do not intend to continue pursuing contract research agreements and government grant projects at the levels we have historically. Over the next 18 months, we expect these revenues to decline as our current contract research agreements and government grant projects conclude and not replaced.

Cost of Product Revenues

Cost of product revenues increased by $378,000, or 134%, for the year ended December 31, 2018 compared to the year ended December 31, 2017. This was due primarily to an inventory write-down recorded in 2018, as well as increased costs related to product revenues this year.

Research and Development

Research and development expenses decreased by $1.3 million, or 18%, for the year ended December 31, 2018 compared to the year ended December 31, 2017. The decrease was primarily driven by the termination of a license and subcontracted research agreement at the end of 2017, as well as less subcontracting expenses in support of government grants. Given our acute focus on the near-term commercialization of our nutritional ingredient traits and products, we do not intend to continue pursuing contract research agreements and government grant projects at the levels we have historically.

Selling, General, and Administrative

Selling, general, and administrative expenses increased by $953,000, or 9%, for the year ended December 31, 2018 compared to the year ended December 31, 2017. The increase was primarily driven by higher intellectual property legal fees and marketing costs in 2018, was partially offset by lower advisory fees and severance costs.

Interest Expense

Interest expense decreased $747,000, or 100%, for the year ended December 31, 2018 compared to the year ended December 31, 2017. This was driven by the extinguishment of debt in July 2017. See Note 10.

Other Income, Net

Other income, net, increased $113,000, or 40%, for the year ended December 31, 2018 compared to the year ended December 31, 2017. This was primarily related to the increase in our short-term investment balance during 2018.

Initial Loss on Common Stock Warrant and Common Stock Adjustment Feature Liabilities

Initial loss on common stock warrant and common stock adjustment feature liabilities of $4.0 million is comprised of the non-cash loss associated with the initial recognition of the common stock warrant and common stock adjustment feature liabilities associated with the Private Placement in March 2018 at estimated fair values of $10.2 million and $3.8 million, respectively. The combined fair value of $14 million less $10 million of proceeds yields the $4.0 million initial loss.

Change in the Estimated Fair Value of Common Stock Warrant Liabilities and Common Stock Adjustment Feature Liability

Change in the estimated fair value of common stock warrant liabilities and common stock adjustment feature liability of $9.6 million for the twelve months ended December 31, 2018 resulted from the fair value remeasurements of the Purchase Agreement liabilities at March 31, 2018 and the final remeasurement of the common stock adjustment feature on May 7, 2018. Also included is the remeasurement of the June Offering liabilities and the Purchase Agreement common stock warrant liabilities through December 31, 2018. The estimated fair value of the Purchase Agreement common stock adjustment feature was $4.6 million, the estimated fair value of the Purchase Agreement common stock warrants decreased by $7.9 million, and the estimated fair value of the June Offering common stock warrants decreased by $6.3 million due to the decrease in the Company's stock price. The Purchase Agreement common stock adjustment feature liability was released to equity following the final fair value remeasurement in May 2018. See Note 11.

Offering Costs

Offering costs for the year ended December 31, 2018 of $2.6 million is comprised of $1.8 million associated with the Private Placement and $721,000 related to the June Offering and the June Private Placement.

Income Tax Provision

The income tax provision decreased $16,000 or 62% for the year ended December 31, 2018 compared to the year ended December 31, 2017.

Seasonality

We and our commercial partners operate in different geographies around the world and conduct field trials used for data generation, which must be conducted during the appropriate growing seasons for particular crops and markets. Often, there is only one crop-growing season per year for certain crops and markets. Similarly, climate conditions and other factors that may influence the sales of our products may vary from season to season and year to year. In particular, weather conditions, including natural disasters such as heavy rains, hurricanes, hail, floods, tornadoes, freezing conditions, drought, or fire, may affect the timing and outcome of field trials, which may delay milestone payments and the commercialization of products incorporating our seed traits. In the future, sales of commercial products that incorporate our seed traits will vary based on crop growing seasons and weather patterns within particular regions.

The level of seasonality in our business overall is difficult to evaluate at this time due to our relatively early stage of development, our relatively limited number of commercialized products, our expansion into new geographical markets, and our introduction of new products and traits.

Liquidity, Capital Resources and Going Concern

We have funded our operations primarily with the net proceeds from our initial public offering and private placements of equity and debt securities, as well as proceeds from the sale of our SONOVA products and payments under license agreements, contract research agreements, and government grants. Our principal use of cash is to fund our operations, which are primarily focused on progressing our agricultural yield and product quality seed traits through the regulatory process and to commercialization. This includes replicating field trials, coordinating with our partners on their development programs, and collecting, analyzing, and submitting field trial data to regulatory authorities. As of December 31, 2018, we had cash and cash equivalents of $12.0 million and short-term investments of $9.8 million. For the years ended December 31, 2018 and 2017, the Company had net losses of $13.5 million and $15.7 million, respectively, and net cash used in operations of $13.6 million and $14.0 million, respectively.

As is disclosed in Note 11, the Company has obtained funding through two separate arrangements during the first half of 2018. On March 19, 2018, the Company entered into securities purchase agreements with institutional investors in connection with a private placement of common stock and warrants in the amount of $10 million, exclusive of any related transaction fees. On June 11, 2018, the Company entered into agreements with institutional investors through a registered direct offering in the amount of $14 million, exclusive of any related transaction fees.

We believe that our existing cash, cash equivalents, and short-term investments will not be sufficient to meet our anticipated cash requirements for at least the next 12 months which raises substantial doubt about the Company's ability to continue as a going concern. See Note 1 of the notes to our consolidated financial statements for more information.

We may seek to raise additional funds through debt or equity financings, if necessary. We may also consider entering into additional partner arrangements. Our sale of additional equity would result in dilution to our stockholders. Our incurrence of debt would result in debt service obligations, and the instruments governing our debt could provide for additional operating and financing covenants that would restrict our operations. If we do require additional funds and are not able to secure adequate additional funding, we may be forced to reduce our spending, extend payment terms with our suppliers, liquidate assets, or suspend or curtail planned development programs. Any of these actions could materially harm our business, results of operations and financial condition.

Term Loans

In December 2015, the Company entered into a loan and security agreement ("Term Loan") with Silicon Valley Bank (the "Bank") providing for a senior secured term loan facility in the amount of $25.0 million, which proceeds were used to repay all existing debt. In July 2017, the Company repaid the $25.0 million Term Loan with Silicon Valley Bank, along with the $625,000 end-of-term fee and $500,000 prepayment fee.

The Term Loan's prepayment and end of term fees of $1.1 million were recorded as a loss on extinguishment of debt, along with $41,000 of deferred loan issuance fees, partially offset by $267,000 of end of term fees previously amortized, netting to a loss of $900,000. As of the payoff date, the Company was in compliance with all covenants.

Cash Flows

The following table summarizes our cash flows for the periods indicated (in thousands):

	Year Ended December 31,	
	2018	2017
Net cash (used in) provided by:		
Operating activities	$ (13,631)	$ (13,965)
Investing activities	(5,975)	47,178
Financing activities	22,479	(26,101)
Net increase in cash and cash equivalents	$ 2,873	$ 7,112

Cash Flows from Operating Activities

Cash used in operating activities for the year ended December 31, 2018 was $13.6 million. Our net loss of $13.5 million, the change in fair value of common stock warrant liabilities and common stock adjustment feature liability of $9.6 million and net amortization of investment premium and discount of $193,000 were partially offset by the initial loss on common stock warrant and adjustment feature liabilities of $4.0 million, non-cash charges of $1.6 million for stock-based compensation, and depreciation and amortization of $154,000, as well as $2.6 million for offering costs included in financing activities and adjustments in our working capital accounts of $1.1 million.

Cash used in operating activities for the year ended December 31, 2017 was $14.0 million. Our net loss of $15.7 million was partly offset by non-cash charges of $1.5 million for stock-based compensation, loss on extinguishment of debt of $900,000, and depreciation and amortization of $279,000. These were partially offset by changes in net operating assets totaling $921,000.

Cash Flows from Investing Activities

Cash used in investing activities for the year ended December 31, 2018 of $6.0 million primarily consisted of $29.9 million in purchases of short-term investments and $250,000 in purchases of property and equipment, partially offset by $24.2 million in proceeds from sales and maturities of investments.

Cash provided by investing activities for the year ended December 31, 2017 of $47.2 million primarily consisted of $66.7 million of proceeds from sales and maturities of investments, partially offset by $19.4 million of net investments purchased.

Cash Flows from Financing Activities

Cash provided by financing activities for the year ended December 31, 2018 consisted of proceeds from the issuance of stock and warrants in March 2018 of $10.0 million and in June 2018 of $14.0 million, partially offset by $2.5 million of offering costs for both transactions paid during the period. Proceeds from the exercise of stock options and the purchase shares under the employee stock purchase plan totaled $969,000.

Cash used in financing activities for the year ended December 31, 2017 of $26.1 million consisted of payments on notes payable and related debt extinguishment costs (Note 10).

Contractual Obligations and Other Commitments

Our future contractual obligations at December 31, 2018 were as follows (in thousands):

	Payments Due by Period(1)(2)				
	Less than 1 year	1 to 3 Years	3 to 5 Years	More than 5 years	Total
Non-cancelable operating leases	$ 704	$ 1,805	$ 295	$ —	$ 2,804
Total contractual obligations	$ 704	$ 1,805	$ 295	$ —	$ 2,804

(1) Does not include any amounts related to contract research or other agreements with unrelated parties that require us to pay certain funding commitments, as these agreements are cancelable by us.

(2) Does not include any payments we may have to make under the contingent liability related to the Anawah acquisition, as the amount and timing of the ultimate payments are unknown. Please see Note 13 of the notes to our consolidated financial statements for more information.

We are obligated to make future payments to related and unrelated parties under in-license agreements, including certain license fees, royalties, and milestone fees. In addition, certain royalty payments ranging from the low single digits to mid-teens are payable on net revenue amounts as defined in the in-licensing agreements. Milestone payments under these agreements may also be payable upon the successful development or implementation of various technologies. The amount and timing of these payments are uncertain and have been excluded from the above table.

Off-Balance Sheet Arrangements

Since our inception, we have not engaged in any off-balance sheet arrangements, including the use of structured finance, special purpose entities, or variable interest entities other than Verdeca, which is discussed in the notes to our consolidated financial statements.

Critical Accounting Polices and Estimates

Our management's discussion and analysis of our financial condition and results of operations is based on our financial statements, which have been prepared in accordance with GAAP. The preparation of these financial statements requires us to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent assets and liabilities at the date of the financial statements, as well as the reported revenue generated, and expenses incurred during the reporting periods. Our estimates are based on our historical experience and on various other factors that we believe are reasonable under the circumstances, the results of which form the basis for making judgments about the carrying value of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

We consider our critical accounting policies and estimates to be revenue recognition, inventories, income taxes, the liabilities relating to the June 2018 Offering, and stock-based compensation. See Notes 5 and 11 for the estimates made in connection with the securities purchase agreements executed during the first six months of 2018 and Note 6 for our accounting policies in effect with the adoption of ASC Topic 606.

Revenue Recognition

We recognize revenue when control of the promised goods or services is transferred to customers at an amount that reflects the consideration to which the entity expects to be entitled to in exchange for those goods or services. See Note 6 for further detail.

We generally recognize product revenues once passage of title has occurred. Shipping and handling costs charged to customers are recorded as revenues and included in cost of product revenues at the time the sale is recognized.

We have determined that, at the inception of each license agreement, there is only one deliverable for the license for, access to, and assistance with the development of the specified intellectual property. We recognize revenue up-front and annual license fees in full when it is deemed probable to be earned. See Note 6 for further detail.

We recognize revenue related to milestone payments when it is probable that such amounts would not be reversed. See Note 6 for further detail.

Up-front license fees for newly executed agreements are recognized upon execution. Annual license fees and milestone fees are variable consideration that is initially constrained and recognized only when it is probable that such amounts would not be reversed. The evaluation and analysis of such fees is performed and once the annual license or milestone fee is deemed probable to have been earned, it is recognized in full in that period. See Note 6 for further detail.

Contract research revenue consists of amounts earned from performing contracted research activities for third parties. Activities performed are related to breeding programs or the genetic engineering of plants and are subject to an executed agreement. We generally recognize fees for research activities ratably over the contractually specified performance period.

Grant revenues are recognized as eligible research and development expenses are incurred using a proportional performance recognition methodology.

Inventories

Inventory costs are tracked on a lot-identified basis, valued at the lower of cost or net realizable value and are included as cost of product sales when sold. We compare the cost of inventories with market value and write down inventories to net realizable value, if lower. We provide write down inventory when conditions indicate that the net realizable value may be less than cost due to physical deterioration, obsolescence, changes in price levels, or other factors. Additionally, we provide reserves for excess and slow-moving inventory to its estimated net realizable value. The inventory write-downs are based upon estimates about future demand from our customers and distributors and market conditions. Future events that could significantly influence our judgment and related estimates include conditions in target markets, introduction of new products or changes to current or future competitor products.

Stock Based Compensation

We recognize compensation expense related to the employee stock purchase plan and stock options granted to employees and directors based on the estimated fair value of the awards on the date of grant, net of estimated forfeitures. We estimate the grant date fair value, and the resulting stock-based compensation expense, using the Black-Scholes option-pricing model. The grant date fair value of the stock-based awards is generally recognized on a straight-line basis over the requisite service period, which is generally the vesting period of the respective awards.

We recognize compensation expense for equity instruments issued to non-employees based on the estimated fair value of the equity instrument. The fair value of the non-employee awards is subject to re-measurement at each reporting period until services required under the arrangement are completed, which is the vesting date.

We recorded stock-based compensation expense related to equity awards of $1.6 million and $1.5 million for the years ended December 31, 2018 and 2017, respectively.

In determining the fair value of stock-based awards, we use the Black-Scholes option-pricing model and assumptions discussed below. Each of these inputs is subjective and generally requires significant judgment to determine.

Expected Term—The expected term represents the period that stock-based awards are expected to be outstanding and was estimated based on historical and anticipated future exercise activity.

Expected Volatility—Since we were privately held and do not have sufficient trading history for our common stock, the expected volatility was estimated based on the average historical volatilities of common stock of comparable publicly traded entities over a period equal to the expected term of the stock option grants. The comparable companies were chosen based on their similar size, stage in the life cycle, or area of specialty. We will continue to apply this process until a sufficient amount of historical information regarding the volatility of our own stock price becomes available.

Risk-Free Interest Rate—The risk-free interest rate is based on the U.S. Treasury zero coupon issues in effect at the time of grant for periods corresponding with the expected term of option.

Expected Dividend—We have never paid dividends on our common stock and have no plans to pay dividends on our common stock. Therefore, we used an expected dividend yield of zero.

For stock options and other equity awards, our board of directors determine the fair value of each share of underlying common stock based on the closing price of our common stock as reported on the NASDAQ Stock Market on the date of grant.

In addition to the Black-Scholes assumptions, we estimate our forfeiture rate based on an analysis of our actual forfeitures and will continue to evaluate the adequacy of the forfeiture rate based on actual forfeiture experience, analysis of employee turnover behavior, and other factors. The impact from any forfeiture rate adjustment would be recognized in full in the period of adjustment and if the actual number of future forfeitures differs from our estimates, we might be required to record adjustments to stock-based compensation in future periods.

Income Taxes

We use the asset and liability method of accounting for income taxes. Under this method, deferred tax assets and liabilities are determined based on the differences between the financial reporting and the tax bases of assets and liabilities and are measured using the enacted tax rates and laws that will be in effect when the differences are expected to reverse. A valuation allowance is provided when it is more likely than not that some portion or all of a deferred tax asset will not be realized.

Recent Accounting Pronouncements

For discussions of the adoption and potential impacts of recently issued accounting standards, refer to Note 3 – Recent Accounting Pronouncements, Note 6 – Adoption of ASC Topic 606 – Revenue, and Note 14 – Leases to the accompanying consolidated financial statements.

Item 7A. Quantitative and Qualitative Disclosures About Market Risk.

The primary objective of our investment activities is to preserve our capital to fund our operations. We also seek to maximize income from our investments without assuming significant risk. To achieve our objectives, we maintain a portfolio of cash equivalents and investments in a variety of securities of high credit quality. As of December 31, 2018, we had cash and cash equivalents of $12.0 million and short-term investments of $9.8 million consisting primarily of cash equivalents and other liquid investments deposited in highly rated financial institutions in the United States. A portion of our investments may be subject to interest rate risk and could fall in value if market interest rates increase. However, because our investments are primarily shortterm in duration, we believe that our exposure to interest rate risk is not significant and a 1% movement in market interest rates would not have a significant impact on the total value of our portfolio. We actively monitor changes in interest rates.

Item 8. Financial Statements and Supplementary Data.

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the stockholders and the Board of Directors of Arcadia Biosciences, Inc.

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of Arcadia Biosciences, Inc. and its subsidiary (the "Company") as of December 31, 2018 and 2017, the related consolidated statements of operations and comprehensive loss, stockholders' equity, and cash flows, for each of the two years in the period ended December 31, 2018, and the related notes (collectively referred to as the "financial statements"). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2018 and 2017, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2018, in conformity with accounting principles generally accepted in the United States of America.

Going Concern

The accompanying consolidated financial statements have been prepared assuming that the Company will continue as a going concern. As discussed in Note 1 to the consolidated financial statements, the Company has suffered recurring losses from operations and is experiencing difficulty in generating sufficient cash flow to meet its obligations and sustain its operations, which raises substantial doubt about its ability to continue as a going concern. Management’s plans in regard to these matters are also described in Note 1. The consolidated financial statements do not include any adjustments that might result from the outcome of this uncertainty.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's consolidated financial statements based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud. The Company is not required to have, nor were we engaged to perform, an audit of its internal control over financial reporting. As part of our audits, we are required to obtain an understanding of internal control over financial reporting but not for the purpose of expressing an opinion on the effectiveness of the Company’s internal control over financial reporting. Accordingly, we express no such opinion.

Our audits included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. We believe that our audits provide a reasonable basis for our opinion.

/s/ Deloitte & Touche LLP

Phoenix, Arizona
April 1, 2019

We have served as the Company's auditor since 2007.

Arcadia Biosciences, Inc.
Consolidated Balance Sheets
(In thousands, except share data)

	As of December 31,	
	2018	**2017**
Assets		
Current assets:		
Cash and cash equivalents	$ 11,998	$ 9,125
Short-term investments	9,825	3,898
Accounts receivable	165	1,231
Unbilled revenue	3	4
Inventories — current	181	229
Prepaid expenses and other current assets	704	560
Total current assets	22,876	15,047
Property and equipment, net	395	299
Inventories — noncurrent	746	1,168
Other noncurrent assets	7	56
Total assets	$ 24,024	$ 16,570
Liabilities and stockholders' equity		
Current liabilities:		
Accounts payable and accrued expenses	$ 2,645	$ 2,496
Amounts due to related parties	29	29
Unearned revenue — current	96	1,000
Other current liabilities	284	—
Total current liabilities	3,054	3,525
Unearned revenue — noncurrent	—	2,038
Common stock warrant liabilities	5,083	—
Other noncurrent liabilities	3,072	3,000
Total liabilities	11,209	8,563
Stockholders' equity:		
Common stock, $0.001 par value—150,000,000 shares authorized as of December 31, 2018 and December 31, 2017; 4,774,919 and 2,134,154 shares issued and outstanding as of December 31, 2018 and December 31, 2017, respectively.	45	42
Additional paid-in capital	191,136	175,223
Accumulated deficit	(178,366)	(167,257)
Accumulated other comprehensive loss	—	(1)
Total stockholders' equity	12,815	8,007
Total liabilities and stockholders' equity	$ 24,024	$ 16,570

The accompanying notes are an integral part of these consolidated financial statements.

Arcadia Biosciences, Inc.
Consolidated Statements of Operations and Comprehensive Loss
(In thousands, except share and share data)

	Year Ended December 31,	
	2018	2017
Revenues:		
Product	$ 657	$ 514
License	150	1,470
Contract research and government grants	657	2,042
Total revenues	1,464	4,026
Operating expenses:		
Cost of product revenues	661	283
Research and development	6,069	7,407
Selling, general and administrative	11,604	10,651
Total operating expenses	18,334	18,341
Loss from operations	(16,870)	(14,315)
Interest expense	—	(747)
Other income, net	394	281
Initial loss on common stock warrant and common stock adjustment feature liabilities	(4,000)	—
Change in fair value of common stock warrant and common stock adjustment feature liabilities	9,561	—
Offering costs	(2,555)	—
Loss on extinguishment of debt	—	(900)
Net loss before income taxes	(13,470)	(15,681)
Income tax provision	(10)	(26)
Net loss attributable to common stockholders	$ (13,480)	$ (15,707)
Net loss per share attributable to common stockholders:		
Basic and diluted	$ (3.58)	$ (7.28)
Weighted-average number of shares used in per share calculations:		
Basic and diluted	3,766,419	2,156,201
Other comprehensive income, net of tax		
Unrealized gains on available-for-sale securities	—	18
Other comprehensive income	—	18
Comprehensive loss attributable to common stockholders	$ (13,480)	$ (15,689)

The accompanying notes are an integral part of these consolidated financial statements.

Arcadia Biosciences, Inc.
Consolidated Statements of Stockholders' Equity
(In thousands, except share data)

	Common Stock		Additional Paid-In Capital	Accumulated Deficit	Accumulated Other Comprehensive Loss	Total Stockholders' Equity
	Shares	Amount				
Balance at January 1, 2017	2,224,384	$ 44	$ 173,723	$ (151,550)	$ (19)	$ 22,198
Issuance of shares related to employee stock purchase plan	1,964	—	24	—	—	24
Stock-based compensation	—	—	1,474	—	—	1,474
Other comprehensive income	—	—	—	—	18	18
Exchange of membership interest in unconsolidated entity for common stock	(92,194)	(2)	2	—	—	—
Net loss	—	—	—	(15,707)	—	(15,707)
Balance at December 31, 2017	2,134,153	$ 42	$ 175,223	$ (167,257)	$ (1)	$ 8,007
Impact of adoption of Topic 606 (Note 6)	—	—	—	2,371	—	2,371
Issuance of shares related to employee stock option exercises	44,354	—	963	—	—	963
Issuance of shares related to employee stock purchase plan	1,122	—	6	—	—	6
Issuance of shares related to Purchase Agreement	1,201,634	1	(1)	—	—	—
Issuance of placement agent warrants related to Purchase Agreement	—	—	526	—	—	526
Common stock adjustment feature	—	—	8,378	—	—	8,378
Issuance of shares related to June Offering	1,392,345	2	4,976	—	—	4,978
Offering costs related to June Offering	—	—	(912)	—	—	(912)
Issuance of placement agent warrants related to June Offering	—	—	427	—	—	427
Stock-based compensation	—	—	1,550	—	—	1,550
Issuance of shares related to reverse stock split	1,311	—	—	—	—	—
Other comprehensive income	—	—	—	—	1	1
Net loss	—	—	—	(13,480)	—	(13,480)
Balance at December 31, 2018	4,774,919	$ 45	$ 191,136	$ (178,366)	$ 0	$ 12,815

The accompanying notes are an integral part of these consolidated financial statements.

Arcadia Biosciences, Inc.
Consolidated Statements of Cash Flows
(In thousands)

	Year Ended December 31,	
	2018	**2017**
CASH FLOWS FROM OPERATING ACTIVITIES:		
Net loss	$ (13,480)	$ (15,707)
Adjustments to reconcile net loss to cash used in operating activities:		
Initial loss on common stock warrant and common stock adjustment feature liabilities	4,000	—
Change in fair value of common stock warrant and common stock adjustment feature liabilities	(9,561)	—
Offering costs	2,555	—
Depreciation	154	279
Gain on disposal of equipment	(3)	(1)
Net amortization of investment premium and discount	(193)	(89)
Stock-based compensation	1,550	1,474
Loss on sale of investments	—	2
Accretion of debt discount	—	98
Loss on extinguishment of debt	—	900
Write down of inventory	310	—
Changes in operating assets and liabilities:		
Accounts receivable	1,066	(882)
Unbilled revenue	2	179
Inventories	160	183
Prepaid expenses and other current assets	(151)	324
Other noncurrent assets	—	11
Accounts payable and accrued expenses	176	87
Amounts due to related parties	(1)	(1)
Unearned revenue	(312)	(822)
Other current liabilities	25	—
Other noncurrent liabilities	72	—
Net cash used in operating activities	(13,631)	(13,965)
CASH FLOWS FROM INVESTING ACTIVITIES:		
Proceeds from sale of property and equipment	10	4
Purchases of property and equipment	(250)	(79)
Purchases of investments	(29,885)	(19,405)
Proceeds from sales and maturities of investments	24,150	66,658
Net cash (used in) provided by investing activities	(5,975)	47,178
CASH FLOWS FROM FINANCING ACTIVITIES:		
Proceeds from issuance of common stock and warrants under Purchase Agreement	10,000	—
Payments of offering costs relating to Purchase Agreement	(1,308)	—
Proceeds from issuance of common stock and warrants from June Offering	14,000	—
Payments of offering costs relating to June Offering	(1,182)	—
Payments of debt extinguishment costs	—	(1,125)
Proceeds from exercise of stock options and purchases through ESPP	969	24
Payments on notes payable	—	(25,000)
Net cash provided by (used in) financing activities	22,479	(26,101)
Net increase in cash and cash equivalents	2,873	7,112
Cash and cash equivalents — beginning of period	9,125	2,013
Cash and cash equivalents — end of period	$ 11,998	$ 9,125
SUPPLEMENTAL DISCLOSURES OF CASH FLOW INFORMATION:		
Cash paid for interest	—	$ 746
Cash paid for income taxes	$ 34	$ 2
NONCASH TRANSACTIONS:		
Offering costs in accounts payable and accrued expenses at end of period	$ 23	$ 50
Common stock warrants issued to placement agent and included in offering costs related to Purchase Agreement	$ 526	$ —
Common stock warrants issued to placement agent and included in offering costs related to June Offering	$ 239	$ —
Proceeds from sale of fixed assets included in prepaid expenses and other current assets	$ —	$ 7
Reclassification of unearned revenue to other short term liabilities	$ 259	$ —
Reclassification of common stock adjustment feature liability balance to equity	$ 8,378	$ —
Exchange of membership interest in unconsolidated entity for common stock	$ —	$ 2

The accompanying notes are an integral part of these consolidated financial statements.

Note 1. Description of Business

Organization

Arcadia Biosciences, Inc. (the "Company"), was incorporated in the state of Arizona in 2002 and maintains its headquarters in Davis, California, with additional facilities in Phoenix, Arizona, and American Falls, Idaho. The Company was reincorporated in Delaware in March 2015.

We are a consumer-driven, agricultural food ingredient company. We aim to create value across the agricultural production and supply chain beginning with enhanced crop productivity for farmers and ultimately delivering accelerated innovation in nutritional quality consumer foods. We use state of the art gene-editing technology and advanced breeding techniques to naturally enhance the nutritional quality of grains and oilseeds to address the rapidly evolving trends in consumer health and nutrition. In addition, we have developed high value crop productivity traits designed to enhance farm economics.

In February 2012, the Company formed Verdeca LLC (“Verdeca,” see Note 7), which is jointly owned by us with Bioceres, Inc. (“Bioceres”), a U.S. wholly owned subsidiary of Bioceres, S.A., an Argentine corporation. Bioceres, S.A. is an agricultural investment and development cooperative. Verdeca, which is consolidated by the Company, was formed to develop and deregulate soybean varieties using both partners’ agricultural technologies.

Reverse Stock Split

In January 2018, the Company’s board of directors approved a reverse split of 1:20 on the Company’s issued and outstanding common stock which became effective on January 23, 2018. All issued and outstanding common stock, options to purchase common stock and per share amounts contained in the consolidated financial statement have been retroactively adjusted to reflect the reverse stock split for all periods presented. The reverse stock split did not change the total number of authorized shares of common stock which remained at one hundred and fifty million shares.

Liquidity, Capital Resources, and Going Concern

The accompanying consolidated financial statements have been prepared on a going concern basis, which contemplates the realization of assets and the satisfaction of liabilities during the normal course of business. Since inception, the Company has financed its operations primarily through equity and debt financings. As of December 31, 2018, the Company had an accumulated deficit of $178.4 million, cash and cash equivalents of $12.0 million, and short-term investments of $9.8 million. For the years ended December 31, 2018 and 2017, the Company had net losses of $13.5 million and $15.7 million, respectively, and net cash used in operations of $13.6 million and $14.0 million, respectively. The Company believes that its existing cash, cash equivalents and investments will be insufficient to meet its anticipated cash requirements for at least through March 2020, and thus raises substantial doubt about the Company’s ability to continue as a going concern. The financial statements do not include any adjustments that might result from the outcome of this uncertainty.

The Company may seek to raise additional funds through debt or equity financings. The Company may also consider entering into additional partner arrangements. The sale of additional equity would result in dilution to the Company’s stockholders. The incurrence of debt would result in debt service obligations, and the instruments governing such debt could provide for additional operating and financing covenants that would restrict operations. If the Company does require additional funds and is unable to secure adequate additional funding at terms agreeable to the Company, the Company may be forced to reduce spending, extend payment terms with suppliers, liquidate assets, or suspend or curtail planned development programs. Any of these actions could materially harm the business, results of operations and financial condition.

Note 2. Summary of Significant Accounting Policies

Basis of Presentation and Principles of Consolidation

The consolidated financial statements include the accounts of the Company and Verdeca LLC. All intercompany balances and transactions have been eliminated in consolidation. The Company prepares its consolidated financial statements in conformity with accounting principles generally accepted in the United States of America, or U.S. GAAP ("GAAP"), and with the rules of the Securities and Exchange Commission. The Company uses a qualitative approach in assessing the consolidation requirement for variable interest entities ("VIEs"). This approach focuses on determining whether the Company has the power to direct the activities of the VIE that most significantly affect the VIE's economic performance and whether the Company has the obligation to absorb losses, or the right to receive benefits, that could potentially be significant to the VIE. For all periods presented, the Company has determined that it is the primary beneficiary of Verdeca, which is a VIE. The Company evaluates its relationships with the VIEs upon the occurrence of certain significant events that affect the design, structure or other factors pertinent to the primary beneficiary determination. Verdeca LLC has no operations, assets or liabilities as of and for the years ended December 31, 2018 and 2017.

Use of Estimates

The preparation of consolidated financial statements in conformity with GAAP requires management to make estimates and assumptions in the Company's consolidated financial statements and notes thereto. Significant estimates and assumptions made by management included the determination of the provision for income taxes, stock-based compensation, fair value of certain equity instruments, costs to complete government grants and research contracts, and net realizable value of inventory. Management bases its estimates on historical experience and on various other market-specific and relevant assumptions that management believes to be reasonable under the circumstances. Actual results could differ from those estimates.

Cash and Cash Equivalents

The Company considers any liquid investments with a stated maturity of three months or less at the date of purchase to be cash equivalents. Cash and cash equivalents consist of cash on deposit with banks. The Company limits cash investments to financial institutions with high credit standings; therefore, management believes that there is no significant exposure to any credit risk in the Company's cash and cash equivalents. However, as of December 31, 2018 and 2017, a substantial portion of the Company's cash in depository accounts is in excess of the federal deposit insurance limits.

Investments in Equity and Debt Securities

The Company uses the equity method to account for investments in equity securities if the investment provides the Company the ability to exercise significant influence over operating and financial policies of the investee. The Company includes its proportionate share of earnings and/or losses of the equity method investee in its Consolidated Statements of Operations and Comprehensive Loss. The carrying value of the equity investments is reported using the equity method in the Consolidated Balance Sheets. On March 31, 2017, the Company and Vilmorin USA ("VUSA") entered into a non-cash exchange agreement, which the Company transferred to VUSA the Company's entire membership interest in Limagrain Cereal Seeds LLC and VUSA transferred to the Company 92,194 shares of the Company's common stock held by Limagrain. The Company recorded the retirement of the shares using the cost method, resulting in an equity reclassification between common stock par value and additional paid-in capital

Investments in equity securities in which the Company holds less than 20% voting interest and on which the Company does not have the ability to exercise significant influence, and do not have readily determinable fair values are accounted for under the cost method. Cost method investments are originally recorded at cost and are reported on the Consolidated Balance Sheets.

Investments in debt securities are carried at fair value and classified as available-for-sale. Realized gains and losses on available-for-sale securities are included in other income — net in the Consolidated Statements of Operations and Comprehensive Loss. Unrealized gains and losses, net of deferred taxes, on available-for-sale securities are included in the Consolidated Balance Sheets as a component of accumulated other comprehensive income. Securities classified as available-for-sale are reported as cash and cash equivalent, short-term investments or long-term investments in the Consolidated Balance Sheets based on the nature of the investments and maturity period. Short-term investments have maturities of less than a year and long-term investments have maturities of a year and greater from the balance sheet date. The Company's debt securities are primarily comprised of U.S. government securities, treasury bills, commercial paper, corporate securities, and money markets. These available-for-sale investments are held in the custody of a major financial institution.

Other-than-Temporary Impairments on Investment

The Company regularly reviews each of its investments for impairment by determining if the investment has sustained an other-than-temporary decline in its value, in which case the investment is written down to its fair value by a charge to earnings. Factors that are considered by the Company in determining whether an other-than-temporary decline in value has occurred include (i) the market value of the investment in relation to its cost basis, (ii) the financial condition of the investment, and (iii) the Company's intent and ability to retain the investment for a sufficient period of time to allow for recovery of the market value of the investment. As of December 31, 2018, and 2017, there was no impairment of the Company's investments.

Accounts Receivable

Accounts receivable represents amounts owed to the Company from product sales, licenses and contract research and government grants. The carrying value of the Company's receivables represents estimated net realizable values. The Company generally does not require collateral and estimates any required allowance for doubtful accounts based on historical collection trends, the age of outstanding receivables, and existing economic conditions. If events or changes in circumstances indicate that specific receivable balances may be impaired, further consideration is given to the collectability of those balances and the allowance is recorded accordingly. Past-due receivable balances are written off when the Company's internal collection efforts have been unsuccessful in collecting the amounts due. The Company had no amounts reserved for doubtful accounts at December 31, 2018 and 2017 as the Company expected full collections of all accounts receivable balances as of each of these dates.

SONOVA® Gamma Linolenic Acid ("GLA") Safflower Oil Inventory

Proprietary safflower plants are grown, producing seed with a high-GLA content. This seed is used for subsequent plantings or processed, and sold as GLA oil, including SONOVA 400 GLA safflower oils and SONOVA Ultra GLA safflower oil, which we refer to as our SONOVA products. Amounts inventoried consist primarily of fees paid to contracted cooperators to grow the crops and costs to process and store harvested seed. Inventory costs are tracked on a lot-identified basis and are included as cost of product revenues when sold. Inventories are stated at the lower of cost or net realizable value. The Company makes adjustments to inventory when conditions indicate that the net realizable value may be less than cost due to physical deterioration, obsolescence, changes in price levels, or other factors. Additional adjustments to inventory are made for excess and slow-moving inventory on hand that is not expected to be sold within a reasonable timeframe to reduce the carrying amount to its estimated net realizable value. The write downs to inventory are based upon estimates about future demand from the Company's customers and distributors and market conditions.

The inventories—current line item in the balance sheet consists of the cost of oil inventory forecasted to be sold in the next 12 months, as of the balance sheet date. The inventories—noncurrent line item consists of oil and seed inventory expected to be used in production or sold beyond the next 12 months, as of the balance sheet date.

Raw materials inventories consist primarily of seed production costs incurred by our contracted cooperators. Finished goods inventories consist of GLA oil that is available for sale. The Company recorded a $310,000 write-down of inventory for the year ended December 31, 2018. A write-down was not recorded for the year ended December 31, 2017. Inventories consist of the following (in thousands):

	As of December 31,	
	2018	2017
Raw Materials	$ 41	$ 45
Finished Goods	886	1,352
Inventories	$ 927	$ 1,397

Property and Equipment

Property and equipment acquisitions are recorded at cost. Provisions for depreciation are calculated using the straight-line method over the following average estimated useful lives of the assets:

	Years
Laboratory equipment	5
Software and computer equipment	3
Furniture and fixtures	7
Vehicles	5
Leasehold improvements	2-10*

* *Leasehold improvements are depreciated over the shorter of the estimated life of the asset or the remaining life of the lease.*

Impairment of Long-Lived Assets

The Company evaluates if events and circumstances have occurred that indicate the remaining estimated useful life of long-lived assets and identifiable intangible assets may warrant revision or that the remaining balance of these assets may not be recoverable. In evaluating for recoverability, the Company estimates the future undiscounted cash flows expected to result from the use of the assets and their eventual disposition. In the event that the balance of any asset exceeds the future undiscounted cash flow estimate, impairment is recognized based on the excess of the carrying amounts of the asset above its estimated fair value. As of December 31, 2018, and 2017, there was no impairment of the Company's long-lived assets.

Fair Value of Financial Instruments

Fair value accounting is applied for all financial assets and liabilities and non-financial assets and liabilities that are recognized or disclosed at fair value in the consolidated financial statements on a recurring basis. Assets and liabilities recorded at fair value in the consolidated financial statements are categorized based upon the level of judgment associated with the inputs used to measure their fair value. Hierarchical levels, which are directly related to the amount of subjectivity associated with the inputs to the valuation of these assets or liabilities, are as follows:

- Level 1 inputs are quoted prices (unadjusted) in active markets for identical assets or liabilities that the Company can access at the measurement date.
- Level 2 inputs are observable inputs other than quoted prices in active markets for identical assets and liabilities, quoted prices for identical or similar assets or liabilities in inactive markets, or other inputs that are observable or can be corroborated by observable market data for substantially the full term of the assets or liabilities.
- Level 3 inputs are unobservable inputs for the asset or liability.

The carrying values of the Company's financial instruments, including cash equivalents, accounts receivable, and accounts payable, approximated their fair values due to the short period of time to maturity or repayment.

Concentration of Risk

Cash and cash equivalents are maintained with several financial institutions. Deposits held with banks may exceed the amount of insurance provided on such deposits. Generally, these deposits may be redeemed upon demand and are maintained with financial institutions with reputable credit and therefore bear minimal credit risk. The Company seeks to mitigate its credit risks by spreading such risks across multiple counterparties and monitoring the risk profiles of these counterparties.

Customer Concentration

Significant customers are those that represent greater than 10% of the Company's total revenues or gross accounts receivable balance at each respective balance sheet date.

Customers representing greater than 10% of accounts receivable were as follows (in percentages):

	As of December 31,	
	2018	2017
Customer A	—	18
Customer D	—	53
Customer E	—	24
Customer I	44	—
Customer M	34	1

Customers representing greater than 10% of total revenues were as follows (in percentages):

	For Year Ended December 31,	
	2018	2017
Customer A	—	26
Customer D	19	18
Customer L	16	9
Customer I	13	2
Customer M	11	2
Customer K	—	14

Stock-Based Compensation

The Company recognizes compensation expense related to employee stock purchase plan and the cost of stock-based compensation awards made to employees and directors on a straight-line basis over the requisite service period, net of estimated forfeitures. Judgment is required in estimating the amount of stock-based awards that will be forfeited prior to vesting. Compensation expense could be revised in subsequent periods if actual forfeitures differ from those estimates. The Company has selected the Black-Scholes option-pricing model and various inputs to estimate the fair value of its stock-based awards. See Note 12 for additional information.

The Company accounts for compensation expense related to stock options granted to non-employees based on the fair values estimated using the Black-Scholes model. Stock options granted to non-employees are re-measured at each reporting date until the award is vested.

Income Taxes

The Company uses the asset and liability method of accounting for income taxes. Under this method, deferred tax assets and liabilities are determined based on the differences between the financial reporting and the tax bases of assets and liabilities and are measured using the enacted tax rates and laws that will be in effect when the differences are expected to reverse. A valuation allowance is provided when it is more likely than not that some portion or all of a deferred tax asset will not be realized.

Net Loss per Share

Basic net loss per share, which excludes dilution, is computed by dividing the net loss attributable to common stockholders by the weighted-average number of shares of common stock outstanding during the period. Diluted net loss per share reflects the potential dilution that could occur if securities or other contracts to issue common stock, such as stock options, convertible promissory notes, convertible preferred stock, redeemable convertible preferred stock and warrants, result in the issuance of common stock which share in the losses of the Company. Certain potential shares of common stock have been excluded from the computation of diluted net loss per share as their effect would be anti-dilutive. Such potentially dilutive shares are excluded when the effect would be to reduce the loss per share. Due to net losses, there is no impact on earnings per share calculation in applying the two-class method since the participating securities have no legal requirement to share in any losses.

Revenue Recognition

We derive our revenues from product revenues, licensing agreements, contract research agreements, and government grants.

Product Revenues

Our product revenues to date have consisted solely of sales of our SONOVA products. We generally recognize revenue from product sales upon sale to our third-party distributors or customers.

License Revenues

Our license revenues to date consist of up-front, nonrefundable license fees, annual license fees, and subsequent milestone payments that we receive under our research and license agreements. We have historically recognized nonrefundable up-front license fees and guaranteed, time-based payments as revenue proportionally over the expected development period. With the implementation of ASC Topic 606, revenue generated from up-front license fees are recognized upon execution of the agreement. We recognize annual license fees when it is probable that a material reversal will not occur.

Milestone fees are a variable consideration that is initially constrained and recognized only when it is probable that such amounts would not be reversed. The Company assesses when achievement of milestones is probable to determine the timing of revenue recognition for milestone fees. Milestones typically consist of significant stages of development for our traits in a potential commercial product, such as achievement of specific technological targets, completion of field trials, filing with regulatory agencies, completion of the regulatory process, and commercial launch of a product containing our traits. Given the seasonality of agriculture and time required to progress from one milestone to the next, achievement of milestones is inherently uneven, and our license revenues are likely to fluctuate significantly from period to period.

Contract Research Revenues

Contract research and government grant revenues consist of amounts earned from performing contracted research primarily related to breeding programs or the genetic engineering of plants for third parties. Contract research revenue is accounted for as a single performance obligation for which revenues are recognized over time using the input method (e.g. costs incurred to date relative to the total estimated costs at completion). In addition, we are entitled to receive a portion of the revenues generated from sales of products that incorporate our seed traits. Products expected to result from such contract research are in various stages of the product development cycle and we expect to generate revenues from the sale of any such products in as soon as the next nine to 18 months.

Government Grant Revenues

The Company receives payments from government entities in the form of government grants. Government grant revenue is accounted for as a single performance obligation for which revenues are recognized over time using the input method (e.g. costs incurred to date relative to the total estimated costs at completion). The Company's obligation with respect to these agreements is to perform the research on a best-efforts basis. Given the nature and uncertain timing of receipt of government grants and timing of eligible research and development expenses, such revenues are likely to fluctuate significantly from period to period.

Unearned Revenue

The Company defers revenue to the extent that cash received in conjunction with a license agreement, contract or grant exceeds the revenue recognized in accordance with Company policies.

Cost of Product Revenues

Cost of product revenues relates to the sale of our SONOVA products and consists of in-licensing and royalty fees, any adjustments or write-downs to inventory, as well as the cost of raw materials, including inventory and third-party services costs related to procuring, processing, formulating, packaging, and shipping our SONOVA products.

Research and Development Expenses

Research and development expenses consist of costs incurred in the discovery, development, and testing of our products and products in development incorporating our traits. These expenses consist primarily of employee salaries and benefits, fees paid to subcontracted research providers, fees associated with in-licensing technology, land leased for field trials, chemicals and supplies, and other external expenses. These costs are expensed as incurred. Additionally, as disclosed in Note 13, the Company is required from time to time to make certain milestone payments in connection with the development of technologies. These milestone payments are expensed at the time the milestone is achieved and deemed payable.

Change in the Estimated Fair Value of Common Stock Warrant Liabilities and Common Stock Adjustment Feature Liability

Change in the estimated fair value of common stock warrant liabilities and common stock adjustment feature liability is comprised of the fair value remeasurement of the liabilities associated with the Private Placement and June Private Placement. See Note 11.

Note 3. Recent Accounting Pronouncements

In May 2014, the Financial Accounting Standards Board ("FASB") issued Accounting Standards Update ("ASU") 2014-09, *Revenue from Contracts with Customers,* which requires an entity to recognize the amount of revenue to which it expects to be entitled for the transfer of promised goods or services to customers. The ASU replaces most existing revenue recognition guidance in U.S. GAAP. In August 2015, the FASB issued ASU No. 2015-14, *Revenue from Contracts with Customers (Topic 606)*: Deferral of Effective Date, which defers the effective date of ASU No. 2014-09 by one year allowing early adoption as of the original effective date January 1, 2017. The standard was adopted on January 1, 2018. See Note 6.

In January 2016, the FASB issued ASU No. 2016-01, *Financial Instruments – Overall (Subtopic 825-10): Recognition and Measurement of Financial Assets and Financial Liabilities*. The amendments in this update impacts classification, additional fair value measurement, impairment assessment of equity investments and current required disclosures. This standard is effective for fiscal years beginning after December 15, 2017, and interim periods within those fiscal years, with early adoption permitted if the entity meets certain early application guidance. The Company adopted ASU No. 2016-01 in the current year with no material impact to the consolidated financial statements.

In February 2016, the FASB issued ASU No. 2016-02, *Leases (Topic 842)*. Based on the new standard, lessees would recognize lease assets and lease liabilities for those leases classified as operating leases under previous GAAP and disclose qualitative and quantitative information about leasing arrangements with terms longer than 12 months. The new standard allows a modified-retrospective approach to adoption and is effective for interim and annual periods beginning on January 1, 2019. The adoption will require recording right-of-use assets and corresponding lease obligation liabilities for the current operating leases. Additionally, in July 2018, the FASB issued ASU No. 2018-10, *Codification Improvements to Topic 842, Leases* and ASU No. 2018-11, *Leases (Topic 824) – Targeted Improvements*, both of which are also being evaluated. The Company expects that the adoption of ASU No. 2016-02 will not have a material impact on our Consolidated Statements of Operations and Comprehensive Loss. See Note 14.

In June 2016, the FASB issued ASU No. 2016-13, *Financial Instruments – Credit Losses (Topic 326): Measurement of Credit Losses on Financial Instruments*. The amendments affect loans, debt securities, trade receivables, net investments in leases, off-balance-sheet credit exposures, reinsurance receivables, and any other financial assets not excluded from the scope that have the contractual right to receive cash. The amendments in this update are effective for fiscal years beginning after December 15, 2019, including interim periods within those fiscal years. The Company is currently evaluating the impact of the adoption of ASU No. 2016-13 on its consolidated financial statements.

In August 2016, the FASB issued ASU No. 2016-15, *Statement of Cash Flows (Topic 230): Classification of Certain Cash Receipts and Cash Payments*. The amendments address cash flow issues such as debt prepayment or debt extinguishment costs and zero-coupon debt instruments. The amendments in this update are effective for fiscal years beginning after December 15, 2018, and interim periods within fiscal years beginning after December 15, 2019. Early adoption is permitted, including adoption in an interim period. The amendments are to be applied using a retrospective transition method to each period presented. If it is impractical to retrospectively apply, it can be applied prospectively as of the earliest date practicable. The Company adopted ASU No. 2016-15 in the current year with no material impact to the consolidated financial statements.

In May 2017, the FASB issued ASU No. 2017-09, *Compensation – Stock Compensation (Topic 718): Scope of Modification Accounting*. The amendments affect any entity that changes the terms or conditions of a share-based payment award. The amendments in this update are effective for all entities for annual periods, and interim periods within those annual periods, beginning after December 15, 2017. The Company adopted ASU No. 2017-09 in the current year with no material impact to the consolidated financial statements.

In February 2018, the FASB issued ASU No. 2018-03, *Technical Corrections and Improvements to Financial Instruments — Overall (Subtopic 825-10)*: Recognition and Measurement of Financial Assets and Financial Liabilities, which retained the current framework for accounting for financial instruments in generally accepted accounting principles (GAAP) but made targeted improvements to address certain aspects of recognition, measurement, presentation, and disclosure of financial instruments. The amendments in this ASU are effective for fiscal years beginning after December 15, 2017, and interim periods within those fiscal years beginning after June 15, 2018. The Company adopted ASU No. 2018-03 in the current year with no material impact to the consolidated financial statements.

In August 2018, the FASB issued ASU No. 2018-13 *Fair Value Measurement (Topic 820) – Disclosure Framework – Changes to the Disclosure Requirements for Fair Value Measurement*. The amendments affect any entity required to make disclosures about recurring or nonrecurring fair value measurements. The amendments are effective for all entities for fiscal years beginning after December 15, 2019. The Company is currently evaluating the impact of the adoption of ASU No. 2018-13 on its consolidated financial statements.

Note 4. Property and Equipment, Net

Property and equipment, net consisted of the following (in thousands):

	As of December 31,	
	2018	2017
Laboratory equipment	$ 2,348	$ 2,404
Software and computer equipment	477	424
Furniture and fixtures	85	147
Vehicles	204	203
Leasehold improvements	2,082	2,002
Property and equipment, gross	5,196	5,180
Less accumulated depreciation and amortization	(4,801)	(4,881)
Property and equipment, net	$ 395	$ 299

Depreciation and amortization expense is $154,000 and $279,000 for the years ended December 31, 2018 and 2017, respectively.

Note 5. Investments and Fair Value Measurements

Available-for-Sale Investments

The Company classified short-term investments as "available-for-sale." These short-term investments are free of trading restrictions. The investments are carried at fair value, based on quoted market prices or other readily available market information. Unrealized gains and losses, net of taxes, are included in accumulated other comprehensive loss, which is reflected as a separate component of stockholder's equity in the Consolidated Balance Sheets. Gains and losses are recognized when realized in the Consolidated Statements of Operations and Comprehensive Loss.

The following tables summarize the amortized cost and fair value of the available-for-sale investment securities portfolio at December 31, 2018 and December 31, 2017, and the corresponding amounts of unrealized gains and losses recognized in accumulated other comprehensive income:

(Dollars in thousands)	Amortized Cost	Unrealized Gains	Unrealized Losses	Estimated Fair Value
December 31, 2018				
Cash equivalents:				
Money market funds	$ 9,902	$ —	$ —	$ 9,902
Commercial paper	1,345	—	—	1,345
Short-term investments:				
Corporate Securities	656	—	—	656
Treasury Bills	1,195	—	—	1,195
Commercial paper	6,776	—	—	6,776
U.S. government securities	1,198	—	—	1,198
Total Assets at Fair Value	$ 21,072	$ —	$ —	$ 21,072

(Dollars in thousands)	Amortized Cost	Unrealized Gains	Unrealized Losses	Estimated Fair Value
December 31, 2017				
Cash equivalents:				
Money market funds	$ 8,943	$ —	$ —	$ 8,943
Short-term investments:				
Commercial paper	1,399	—	—	$ 1,399
U.S. government securities	2,500	—	(1)	$ 2,499
Total Assets at Fair Value	$ 12,842	$ —	$ (1)	$ 12,841

The Company did not have any investment categories that were in a continuous unrealized loss position for more than twelve months as of December 31, 2018. The unrealized gains and losses amounts above are included in accumulated other comprehensive income or loss

As of December 31, 2018, for fixed income securities that were in unrealized loss positions, the Company has determined that (i) it does not have the intent to sell any of these investments, and (ii) it is not more likely than not that it will be required to sell any of these investments before recovery of the entire amortized cost basis. The Company anticipates that it will recover the entire amortized cost basis of such fixed income securities and has determined that no other-than-temporary impairments associated with credit losses were required to be recognized during the year ended December 31, 2018.

Fair Value Measurement

The fair value of the available-for-sale investments at December 31, 2018 were as follows:

	Fair Value Measurements at December 31, 2018			
(Dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Assets at Fair Value				
Cash equivalents:				
Money market funds	$ 9,902	$ —	$ —	$ 9,902
Commercial paper	—	1,345		1,345
Short-term investments:				
Corporate Securities	—	656		656
Treasury Bills	1,195	—		1,195
Commercial paper	—	6,776	—	6,776
U.S. government securities	1,198	—	—	1,198
Total Assets at Fair Value	$ 12,295	$ 8,777	$ —	$ 21,072

The fair value of the available-for-sale investments at December 31, 2017 were as follows:

	Fair Value Measurements at December 31, 2017			
(Dollars in thousands)	**Level 1**	**Level 2**	**Level 3**	**Total**
Assets at Fair Value				
Cash equivalents:				
Money market funds	$ 8,943	$ —	$ —	$ 8,943
Short-term investments:				
Commercial Paper	—	1,399	—	1,399
U.S. government securities	2,499	—	—	2,499
Total Assets at Fair Value	$ 11,442	$ 1,399	$ —	$ 12,841

The Company uses the market approach technique to value its financial instruments and there were no changes in valuation techniques during 2018 or 2017. The Company's financial instruments consist primarily of cash and cash equivalents, accounts receivable, accounts payable and accrued liabilities. For accounts receivable, accounts payable and accrued liabilities, the carrying amounts of these financial instruments as of December 31, 2018 and 2017 were considered representative of their fair values due to their short term to maturity or repayment. Cash equivalents are carried at cost, which approximates their fair value.

The Company's Level 3 liabilities, which were measured and recorded on a recurring basis, consist of liabilities related to the Purchase Agreement and the June Offering described in Note 11. The following table sets forth the establishment of these liabilities, as well as a summary of the changes in the fair value and other adjustments (in thousands):

	(Level 3)			
(Dollars in thousands)	Common Stock Warrant Liability - Purchase Agreement	Common Stock Adjustment Feature Liability - Purchase Agreement	Common Stock Warrant Liability - June Offering	Total
Balance as of December 31, 2017	$ —	$ —	$ —	$ —
Common stock and warrants issued in conjunction with securities purchase agreements	10,200	3,800	9,022	23,022
Change in fair value and other adjustments	(7,846)	4,578	(6,293)	(9,561)
Reclassification of common stock adjustment feature liability balance to equity	—	(8,378)	—	(8,378)
Balance as of December 31, 2018	$ 2,354	$ —	$ 2,729	$ 5,083

Note 6. Adoption of ASC Topic 606, "Revenue from Contracts with Customers"

In May 2014, the FASB issued ASU No. 2014-09 (Topic 606) "Revenue from Contracts with Customers." Topic 606 supersedes the revenue recognition requirements in Topic 605 "Revenue Recognition" (Topic 605) and requires entities to recognize revenue when control of the promised goods or services is transferred to customers at an amount that reflects the consideration to which the entity expects to be entitled to in exchange for those goods or services.

On January 1, 2018, the Company adopted Topic 606 using the modified retrospective method applied to those contracts which were not completed as of January 1, 2018. Results for reporting periods beginning after January 1, 2018 are presented in accordance with Topic 606, while prior period amounts are not adjusted and continue to be reported in accordance with the Company's historical accounting under Topic 605. With the adoption of Topic 606, tax recognition will now follow book recognition for up-front license and commercial value sharing fees. Annual license fees and milestone fees may continue to be recognized differently for book and tax to the extent that revenue recognized for book is prior to cash receipts.

The Company recorded a net reduction to its accumulated deficit of $2.4 million on January 1, 2018, with a corresponding reduction to unearned revenue, due to the cumulative impact of adopting Topic 606. The adjustment pertained to up-front license fees which were previously deferred for which the performance obligation was determined to be complete as of the date of adoption. The impact to revenues with the adoption of Topic 606 for the year ended December 31, 2018 was a decrease of $328,000 relating to the above mentioned up-front license fee revenues.

Revenues represent amounts earned from product sales, grants and contract research and license agreements. As it pertains to product sales and grants and contract research, there are no changes from Topic 605 compared to the adoption of Topic 606. There is a change in methodology from Topic 605 to Topic 606 that impacts the recognition of revenues from license agreements. The Company's license agreements have one performance obligation and various payment terms over a long commercial development timeline ranging from approximately 10 to 20 years. These payment terms may contain, but are not limited to:

1. Up-front non-refundable license fees
2. Annual license fees
3. Milestone fees
4. Commercial value share fees

Under Topic 605, up-front license fees were deferred and amortized over the estimated commercial development timeline. Under Topic 606, such fees will be recognized upon execution of the agreement. The deferred balance remaining from the existing portfolio of license agreements that were executed prior to January 1, 2018 were recorded as a reduction to accumulated deficit upon the adoption of ASC 606 on January 1, 2018. Up-front license fees for newly executed agreements will be recognized upon execution.

Under Topic 605, annual license fees were recognized on the annual due date as such fees were not due if a milestone was met or if termination of the agreement occurred. Under Topic 606, annual license fees are variable consideration that is initially constrained and recognized only when it is probable that such amounts would not be reversed. The evaluation and analysis of such fees is performed and once an annual license fee is deemed probable to have been earned, it is recognized in full in that period.

Under Topic 605, milestone fees were recognized when the Company and partner licensee mutually agreed the milestone had been achieved. Under Topic 606, milestone fees are variable consideration that is initially constrained and recognized only when it is probable that such amounts would not be reversed. The Company assesses when achievement of milestones are probable in order to determine the timing of revenue recognition for milestone fees. Once a milestone is deemed probable to be achieved, it is recognized in full in that period.

There is no change from Topic 605 to Topic 606 pertaining to future commercial value revenue recognition. Commercial value share fees will be recognized based on subsequent sales by the licensee. The Company has not recognized any of these fees to date and does not expect to do so for several years.

Note 7. Variable Interest Entity

In February 2012, the Company formed Verdeca LLC ("Verdeca"), which is equally owned with Bioceres, Inc. ("Bioceres"), a U.S. wholly owned subsidiary of Bioceres, S.A., an Argentine corporation. Bioceres, S.A. is an agricultural investment and development cooperative owned by approximately 300 shareholders, including some of South America's largest soybean growers. Verdeca was formed to develop and deregulate soybean varieties using both partners' agricultural technologies.

Both the Company and Bioceres incur expenses in support of specific activities agreed, as defined by joint work plans, which apply fair market value to each partner's activities. Unequal contributions of services are equalized by the partners through cash payments. Verdeca is not the primary obligor for these activities performed by the Company or Bioceres. An agreement executed in conjunction with the formation of Verdeca specified that if Bioceres determines it requires cash to fund its contributed services (subject to certain annual limits), Bioceres, S.A. may elect to sell shares of its common stock to the Company for an amount not exceeding $5.0 million in the aggregate over a four-year period. The Company determined that its commitment to purchase common stock in Bioceres, S.A. as a means to provide capital to Verdeca resulted in a de facto agency relationship between the Company and Bioceres. The Company considers qualitative factors in assessing the primary beneficiary which include understanding the purpose and design of the VIE, associated risks that the VIE creates, activities that could be directed by the Company, and the expected relative impact of those activities on the economic performance of the VIE. Based on an evaluation of these factors, the Company concluded that it is the primary beneficiary of Verdeca.

Under the terms of the joint development agreement, the Company has incurred direct expenses and allocated overhead in the amount of $947,000 and $912,000 for the years ended December 31, 2018 and 2017, respectively.

Note 8. Accounts Payable and Accrued Expenses

Accounts payable and accrued expenses consisted of the following (in thousands):

	As of December 31,	
	2018	2017
Accounts payable—trade	$ 285	$ 366
Payroll and benefits	1,096	805
Research and development	433	899
Royalty fees due to unrelated parties	187	177
Consulting	92	32
Rent and utilities	91	51
Legal	285	83
Accrued withholding taxes	—	24
Other	176	59
Total accounts payable and accrued expenses	$ 2,645	$ 2,496

Exit or Disposal Activities

In 2016, the Company completed a comprehensive strategic review of its technology programs, pipeline, partner program progress, competitive landscape and market conditions, which resulted in the decision to realign its organizational capabilities to best support the Company's near-term product commercialization needs and preserve cash. As a result, a number of personnel changes were made, including the elimination of 23 positions. The severance costs associated with this reduction in force were $192,000 for one-time employee termination benefits, and $224,000 in severance costs in connection with an executive employment contract, both of which, are recorded in Selling, General, and Administrative expense for the year ended December 31, 2016. A portion of the one-time employee termination benefits was paid out in December 2016 and the remaining severance amount of $389,000 was accrued under payroll and benefits as of December 31, 2016 and paid in 2017. Additionally, the Company closed its Seattle office in March 2017. The Company has no other associated exit or disposal costs pertaining to the years ended December 31, 2018 and 2017.

Note 9. Collaborative Arrangements

In August 2017, the Company entered into a collaborative arrangement for the research, development and commercialization of an improved wheat quality trait in North America. This collaborative arrangement is a contractual agreement with Corteva Agriscience ("Corteva") involves a joint operating activity where both Arcadia and Corteva are active participants in the activities of the collaboration. Arcadia and Corteva participate in the research and development, and Arcadia has the primary responsibility for the intellectual property strategy while Corteva will generally lead the marketing and commercialization efforts. Both parties are exposed to significant risks and rewards of the collaboration and the agreement includes both cost sharing and profit sharing. The activities are performed with no guarantee of either technological or commercial success.

The Company accounts for research and development ("R&D") costs in accordance ASC 730, *Research and Development*, which states R&D costs must be charged to expense as incurred. Accordingly, internal R&D costs are expensed as incurred. Third-party R&D costs are expensed when the contracted work has been performed or as milestone results are achieved.

Note 10. Long-Term Debt

There was no long-term debt as of December 31, 2018 and 2017.

Term Loan

In December 2015, the Company entered into a loan and security agreement ("Term Loan") with Silicon Valley Bank (the "Bank") providing for a senior secured term loan facility in the amount of $25.0 million, which proceeds were used to repay all existing debt. In July 2017, the Company repaid the Term Loan with Silicon Valley Bank, along with the $625,000 end-of-term fee and $500,000 prepayment fee.

The Term Loans' prepayment and end of term fees of $1.1 million were recorded as a loss on extinguishment of debt, along with $41,000 of deferred loan issuance fees, partially offset by $267,000 of end of term fees previously amortized, netting to a loss of $900,000. As of the payoff date, the Company was in compliance with all covenants.

The Company recognized related interest expense of $747,000 for the year ended December 31, 2017, of which $98,000 was related to the debt discount.

Note 11. Private Placement and Registered Direct Offering

Private Placement

On March 22, 2018, the Company issued 300,752 shares of its common stock ("Common Stock") and warrants to purchase up to 300,752 shares of Common Stock with an initial exercise price equal to $45.75 (the "Warrants"), in a private placement (the "Private Placement") in accordance with a securities purchase agreement (the "Purchase Agreement") entered into with certain institutional and accredited investors (collectively, the "Purchasers") on March 19, 2018. The Warrants are immediately exercisable, subject to certain ownership limitations, and expire five years after the date of issuance.

The per share purchase price of the Common Stock and per share exercise price for the Warrants were subject to adjustment based on the volume weighted average price for the three trading days (the "VWAP Calculation") after each of the following: (i) the date that a registration statement covering the resale of the securities being issued in the Private Placement ("Resale Registration Statement") has been declared effective by the SEC, (ii) if a registration statement covering all securities issued in the Private Placement is not declared effective, then the date that the securities can be sold under Rule 144 under the Securities Act of 1933, as amended, and (iii) if later than the dates set forth in item (i) and (ii), then the date that the Company's shareholders approve the Private Placement. After each adjustment, the per share purchase price for Common Stock was automatically reduced to 80% of the VWAP Calculation, and the per share exercise price for the Warrant was automatically reduced, to 110% of the VWAP Calculation; provided, that in no event, will the per share purchase price for the Common Stock or the exercise price for the Warrants be less than $8.322. Upon any adjustment of the per share exercise price for the Warrants, then the number of shares exercisable under the Warrants would be increased so that the aggregate exercise price payable after adjustment was equal to the aggregate exercise price payable prior to such adjustment.

The Company filed the Resale Registration Statement with the SEC on March 30, 2018, and it was declared effective on April 23, 2018. As described above and based upon the applicable VWAP Calculations relating to these events, each of these events caused an adjustment to the number of shares issued in the Private Placement and underlying the Warrants. Following the effectiveness of the Resale Registration Statement, on April 23, 2018 the number of shares issued pursuant to the Purchase Agreement increased from 300,752 to 798,754, the total number of shares issuable upon exercise of the Warrants increased from 300,752 to 799,300 and the per share exercise price of the Warrants reduced from $45.75 to $17.2143. The Company held a special meeting of its shareholders on May 2, 2018 and obtained shareholder approval for the issuance of Common Stock in the Private Placement. Following shareholder approval of the issuance of shares in the Private Placement, on May 8, 2018 the number of shares issued pursuant to the Purchase Agreement increased from 798,754 to 1,201,634, the total number of shares issuable upon exercise of the Warrants increased from 799,300 to 1,282,832 and the per share exercise price of the Warrants reduced from $17.2143 to $10.7258.

The aggregate net proceeds received by the Company from the Private Placement was $8.7 million, consisting of gross proceeds of $10.0 million less offering costs of $1.3 million. The Company entered into the Private Placement to secure additional capital to strengthen its cash resources required to launch its new health and nutrition ingredient product commercialization and production scale-up plans, as well as to continue the deregulation and commercialization of its stress tolerant HB4 soybean trait. More specifically, net proceeds will be used for working capital to fund the continued introgression of quality ingredient traits into elite germ plasm, additional seed bulk-up, increased planting acreage, consumer brand development and a number of other pre-commercialization and commercialization activities.

The common stock adjustment feature and common stock warrants were determined to be liabilities based on each instrument's adjustment features and the contingent cash payment feature of the common stock warrants. The liabilities were accounted for at their respective fair values at inception using a Monte Carlo simulation model with the following assumptions: volatility of 100 percent, stock price of $32.52 and risk-free rate of 2.63%. At inception, the fair values of the common stock adjustment feature and the common stock warrant liabilities were $3.8 million and $10.2 million, respectively. As the combined value of the liabilities exceeded the $10.0 million of proceeds, no value was assigned to the common stock issued and an initial loss of $4.0 million was recognized.

In May 2018, following the Private Placement's final adjustment, the terms of the warrants and the number of common stock shares issuable in the private placement became known and fixed. As a result, the common stock adjustment feature liability was marked-to-market and valued at $8.4 million at May 7, 2018, resulting in an additional loss of $2.4 million recognized in the second quarter of 2018. The Company subsequently reclassified the common stock adjustment feature liability's balance of $8.4 million to stockholders' equity. The common stock warrant liability was marked-to-market and valued at $2.4 million at December 31, 2018, resulting in income of $7.9 million recognized throughout the year ended December 31, 2018.

Registration Rights Agreement

In connection with the Private Placement, the Company entered into a registration rights agreement (the "Registration Rights Agreement"). Pursuant to the Registration Rights Agreement, the Company filed the Resale Registration Statement with the SEC on March 30, 2018 for purposes of registering the resale of the shares of Common Stock issued pursuant to the Purchase Agreement and the shares of Common Stock issuable upon exercise of the Warrants. The SEC declared the registration statement effective on April 23, 2018.

Offering Costs

In connection with the Private Placement, the Company paid to a placement agent an aggregate fee equal to $850,000. The Company also granted warrants to purchase a total of 15,038 shares of common stock (the "Placement Agent Warrants") that have an exercise price per share equal to $41.5625 and a term of five years. The Placement Agent Warrants were issued for services performed by the placement agent as part of the Private Placement and were treated as offering costs. The value of the Placement Agent Warrants was determined to be $526,000 using the Black-Scholes Model with input assumptions including the Company's stock price, expected life of the warrants, stock price volatility determined from the Company's historical stock prices and the volatility of a peer group, and the risk-free interest rate for the term of the warrants. The Company incurred additional offering costs totaling $458,000 that consist of direct incremental legal, advisory, accounting and filing fees relating to the Private Placement. The offering costs, inclusive of the Placement Agent Warrants, totaled $1.8 million was expensed in the year ended December 31, 2018.

Registered Direct Offering

On May 11, 2018, the Company filed a shelf Registration Statement on Form S-3 with the SEC which was declared effective on June 8, 2018. This shelf registration process allows the Company to sell any combination of common stock, preferred stock, warrants and units consisting of such securities in one or more offerings from time to time having an aggregate initial offering price of $50 million.

On June 11, 2018, the Company entered into agreements with several institutional and accredited investors (the "June Purchase Agreement") for the purchase of 1,392,345 shares of its common stock at a purchase price of $9.93 per share for gross proceeds of $13.8 million (the "June Offering"). The 1,392,345 shares of common stock sold in the June Offering were issued pursuant to a prospectus, dated June 8, 2018, and a prospectus supplement dated June 11, 2018, in connection with a takedown from the Company's shelf Registration Statement on Form S-3. The June Offering closed on June 14, 2018.

Additionally, in a concurrent private placement (the "June Private Placement"), the Company issued to the investors unregistered warrants to purchase up to 1,392,345 shares of common stock at a purchase price per warrant of $0.125, for gross proceeds of $174,000. The warrants, and the shares of common stock underlying the warrants, have not been registered with the SEC and have an exercise price of $9.94 per share. Subject to certain ownership limitations, the warrants are exercisable upon issuance and expire five and one-half years after the date of issuance.

The aggregate net proceeds received by the Company for the June Offering were $12.8 million, consisting of gross proceeds of $14.0 million less offering costs of $1.2 million. The Company intends to use the net proceeds from this offering for general corporate purposes, including, but not limited to, scale-up of its GoodWheat™ Resistant Starch wheat production, early commercialization activities, continued research and development activities and for general and administrative expenses.

The common stock warrants were determined to be a liability as they have a contingent cash payment feature. The common stock warrants were accounted for at their fair value at inception using a Black Scholes Merton model with the following assumptions: volatility of 108 percent, stock price of $8.20 and risk-free rate of 2.83%. At inception, the fair value of the common stock warrants was $9.0 million and the remaining $5.0 million of the $14.0 million of proceeds was allocated to the common stock using the residual method and accounted for as stockholders' equity. The common stock warrants were marked-to-market and valued at $2.7 million at December 31, 2018, resulting in income of $6.3 million recognized throughout the year ended December 31, 2018.

Offering Costs

In connection with the June Offering, the Company paid to a placement agent an aggregate fee equal to $980,000. The Company also granted warrants to purchase a total of 69,617 shares of common stock ("June Placement Agent Warrants") that have an exercise price per share equal to $12.568 and a term of five years. The Placement Agent Warrants were issued for services performed by the placement agent as part of the June Offering and were treated as offering costs. The value of the June Placement Agent Warrants was determined to be $427,000 using the Black-Scholes Model with input assumptions including the Company's stock price, expected life of the warrants, stock price volatility determined from the Company's historical stock prices and the volatility of a peer group, and the risk-free interest rate for the term of the warrants. The Company incurred additional offering costs totaling $197,000 that consist of direct incremental legal, advisory, accounting and filing fees relating to the June Offering. The offering costs, inclusive of the June Placement Agent Warrants, totaled $1.6 million and allocated to the common stock warrant liability and the common stock using their relative fair values. A total of $721,000 was allocated to the common stock warrant liability for the year ended December 31, 2018. The remaining $911,000 was allocated to the common stock and offset to additional paid in capital.

Registration of Warrant Shares

On December 27, 2018, the Company filed a Registration Statement ("Form S-1") with the SEC on December 27, 2018 to register for resale the 15,038 Placement Agent Warrants issued in connection with the Private Placement, and 1,392,345 common stock warrants and 69,617 June Placement Agent Warrants issued in connection with the June Private Placement. The Form S-1 was declared effective on February 15, 2019.

Note 12. Stock-Based Compensation and Warrants

Stock Incentive Plans

The Company has two equity incentive plans: the 2006 Stock Plan ("2006 Plan") and the 2015 Omnibus Equity Incentive Plan ("2015 Plan").

In 2006, the Company adopted the 2006 Plan, which provided for the granting of stock options to executives, employees, and other service providers under terms and provisions established by the Board of Directors. The Company granted non-statutory stock options ("NSOs") under the 2006 Plan until May 2015, when it was terminated as to future awards, although it continues to govern the terms of options that remain outstanding and were issued under the 2006 Plan. The 2015 Plan became effective upon the Company's IPO in May 2015 and all shares that were reserved, but not issued, under the 2006 Plan were assumed by the 2015 Plan. Upon effectiveness, the 2015 Plan had 154,387 shares of common stock reserved for future issuance, which included 10,637 that were transferred to and assumed by the 2015 Plan. The 2015 Plan provides for automatic annual increases in shares available for grant. In addition, shares subject to awards under the 2006 Plan that are forfeited or canceled will be added to the 2015 Plan. The 2015 Plan provides for the grant of incentive stock options ("ISOs"), NSOs, restricted stock awards, stock units, stock appreciation rights, and other forms of equity compensation, all of which may be granted to employees, officers, non-employee directors, and consultants. The ISOs and NSOs will be granted at a price per share not less than the fair value at the date of grant. Options granted generally vest over a four-year period, with 25% vesting at the end of one year and the remaining vesting monthly thereafter; however, the options granted in the third quarter of 2018 vest over a two-year period, vesting monthly on a pro-rated basis. Options granted, once vested, are generally exercisable for up to 10 years, after grant.

As of December 31, 2018, a total of 494,191 shares of common stock were reserved for issuance under the 2015 Plan, of which 26,349 shares of common stock are available for future grant. As of December 31, 2018, a total of 62,202 and 467,842 options are outstanding under the 2006 and 2015 Plans, respectively.

The following is a summary of stock option information and weighted average exercise prices under the Company's stock incentive plans (in thousands, except share data and price per share):

	Shares Subject to Outstanding Options	Weighted-Average Exercise Price Per Share	Aggregate Intrinsic Value
Outstanding — Balance at December 31, 2016	228,939	$ 87.60	$ —
Options granted	111,336	9.20	
Options exercised	—	—	
Options forfeited	(24,334)	31.75	
Options expired	(27,812)	98.95	
Outstanding — Balance at December 31, 2017	288,129	63.62	$ —
Options granted	302,077	6.65	
Options exercised	(44,354)	21.73	
Options forfeited	(4,006)	14.21	
Options expired	(11,802)	43.73	
Outstanding — Balance at December 31, 2018	530,044	35.53	$ —
Vested and expected to vest — December 31, 2018	519,655	35.91	$ —
Exercisable —December 31, 2018	183,300	$ 71.47	$ —

Aggregate intrinsic value represents the difference between the exercise price of the options and the estimated fair value of the Company's common stock determined by our Board of Directors for each of the respective periods. The intrinsic value of options exercised was $0 for the years ended December 31, 2017 and 2018.

At December 31, 2018 and 2017, the total grant-date fair value of shares vested during the years was $1.3 million and $449,000, respectively.

As of December 31, 2018, there was $1.2 million of unrecognized compensation cost related to unvested stock-based compensation grants that will be recognized over the weighted-average remaining recognition period of 2.1 years.

In determining the fair value of the stock-based awards, the Company uses the Black-Scholes option-pricing model and assumptions discussed below. Each of these inputs is subjective and generally requires significant judgment to determine.

Expected Term—The expected term is the estimated period of time outstanding for stock options granted and was estimated based on historical, as well as anticipated future, exercise activity.

Expected Volatility—Since the Company was privately held and does not have a long trading history for its common stock, the expected volatility was estimated based on the average volatility for comparable publicly traded biotechnology companies over a period equal to the expected term of the stock option grants. When selecting comparable publicly traded biotechnology companies on which it has based its expected stock price volatility, the Company selected companies with comparable characteristics to it, including enterprise value, risk profiles, position within the industry, and with historical share price information sufficient to meet the expected life of the stock-based awards. The historical volatility data was computed using the daily closing prices for the selected companies' shares during the equivalent period of the calculated expected term of the stock-based awards. The Company will continue to apply this process until a sufficient amount of historical information regarding the volatility of its own stock price becomes available.

Risk-Free Interest Rate—The risk-free interest rate is based on the interest rate of U.S. Treasuries of comparable maturities on the date the options were granted.

Expected Dividend—The expected dividend yield is based on the Company's expectation of future dividend payouts to common stockholders.

The fair value of stock option awards to employees was estimated at the date of grant using a Black-Scholes option-pricing model with the following weighted-average assumption:

	Year Ended December 31,	
Assumptions	**2018**	**2017**
Expected term (years)	5.99	6.12
Expected volatility	99%	79%
Risk-free interest rate	2.95%	1.90%
Expected dividend yield	—	—

The weighted- average, estimated grant date fair value of employee stock options granted during the years ended December 31, 2018 and 2017 was $6.65 and $9.20, respectively. The Company recognized $1.6 million and 1.5 million of compensation expense for stock options to employees and board members for the years ended December 31, 2018 and 2017, respectively.

Employee Stock Purchase Plan

The Company's 2015 Employee Stock Purchase Plan ("ESPP") became effective on May 14, 2015. The ESPP allows eligible employees to purchase shares of the Company's common stock at a discount of up to 15% of their eligible compensation through payroll deductions, subject to any plan limitations. After the first offering period, which began on May 14, 2015 and ended on February 1, 2016, the ESPP provides for six-month offering periods, and at the end of each offering period, employees are able to purchase shares at 85% of the lower of the fair market value of the Company's common stock on the first trading day of the offering period or on the last day of the offering period. As of December 31, 2018, the number of shares of common stock reserved for future issuance under the ESPP is 89,489. The ESPP provides for automatic annual increases in the shares available for purchase beginning on January 1, 2016. As of December 31, 2018, 6,853 shares had been issued under the ESPP. The Company recorded $11,000 and $13,000 of ESPP related compensation expense for the years ended December 31, 2018 and 2017, respectively.

Warrants

As of December 31, 2018, the Company had 2,822,903 common stock warrants outstanding with a weighted average exercise price of $18.37. The expiration of the warrants ranges from March 2019 to June 2023.

On December 2013, the Company issued warrants to Mahyco International to purchase 3,784 shares of common stock, exercisable as of the issuance date, at an exercise price of $330.40 per share. These warrants expired on December 11, 2018.

In connection with the Series D preferred stock financing in the first half of 2014, the Company issued warrants, exercisable as of the issuance date, to the Series D preferred stock investors to purchase an aggregate of 61,397 shares of common stock at an exercise price of $363.20 per share and to the placement agents to purchase 1,674 shares of common stock at $268.80. The warrants expire five years from the issuance date.

As of December 31, 2018, 1,297,870 common stock warrants are outstanding that were issued in the June Private Placement. The final exercise price for these warrants is $10.7258 as adjusted in accordance with the Purchase Agreement's adjustment provisions. See Note 11.

As of December 31, 2018, 1,461,962 common stock warrants are outstanding in accordance with the June Offering. Of the total, 1,392,345 shares have a purchase price of $9.94 and the remaining 69,617 common stock warrants have an exercise price of $12.568. See Note 11.

Note 13. Commitments and Contingencies

Leases

The Company leases office and laboratory space, greenhouse space, grain storage bins, warehouse space, and equipment under operating lease agreements having initial lease terms ranging from one to five years, including certain renewal options available to the Company at market rates. The Company also leases land for field trials on a short-term basis. Future minimum payments under non-cancelable operating leases in effect as of December 31, 2018, are presented below (in thousands):

Years Ending December 31,	Amounts
2019	704
2020	713
2021	595
2022	497
2023	295
Total future minimum payments under non-cancelable operating leases	$ 2,804

Rent expense under all operating leases totaled $1.3 and $1.2 million for years ended December 31, 2018 and 2017, respectively.

Legal Matters

From time to time, in the ordinary course of business, the Company may become involved in certain legal proceedings. Except as discussed in Item 3, we currently are not a party to any material legal proceedings.

Contingent Liability Related to the Anawah Acquisition

On June 15, 2005, the Company completed its agreement and plan of merger and reorganization with Anawah, Inc. ("Anawah"), to purchase the Anawah's food and agricultural research company through a non-cash stock purchase. Pursuant to the merger with Anawah, and in accordance with the ASC 805 - Business Combinations, the Company incurred a contingent liability not to exceed $5.0 million. This liability represents amounts to be paid to Anawah's previous stockholders for cash collected on revenue recognized by the Company upon commercial sale of certain specific products developed using technology acquired in the purchase. As of December 31, 2010, the Company ceased activities relating to three of the six Anawah product programs thus, the contingent liability was reduced to $3.0 million. During the third quarter of 2016, one of the programs previously accrued for was abandoned and another program previously abandoned was reactivated. As of December 31, 2018, the Company continues to pursue a total of three development programs using this technology and believes that the contingent liability is probable. As a result, $3.0 million remains on the Consolidated Balance Sheet as an other noncurrent liability.

Contracts

The Company has entered into contract research agreements with unrelated parties that require the Company to pay certain funding commitments. The initial terms of these agreements range from one to three years in duration and in certain cases are cancelable.

The Company licenses certain technologies via executed agreements ("In-Licensing Agreements") that are used to develop and advance the Company's own technologies. The Company has entered into various In-Licensing Agreements with related and unrelated parties that require the Company to pay certain license fees, royalties, and/or milestone fees. In addition, certain royalty payments ranging from 2% to 15% of net revenue amounts as defined in the In-Licensing Agreements will be due.

Royalties due to both related and unrelated parties on license revenue accrued as of December 31, 2018 and 2017 were $216,000 and $206,000, respectively. Royalties are included within research and development on the Consolidated Statements of Operations and Comprehensive Loss.

Milestone payments are contingent upon the successful development or implementation of various technologies. Payments for milestones yet to be achieved totaled $2.0 million each year for the years ended December 31, 2018 and 2017. The timing of the payments is not determinable at this time pending research and development currently in progress; however, no significant payments were made during the years ended December 31, 2018 and 2017.

The Company could be adversely affected by certain actions by the government as it relates to government contract revenue received in prior years. Government agencies, such as the Defense Contract Audit Agency routinely audit and investigate government contractors. These agencies review a contractor's performance under its agreements; cost structure; and compliance with applicable laws, regulations and standards. The agencies also review the adequacy of, and a contractor's compliance with, its internal control systems and policies, including the contractor's purchasing, property, estimating, compensation and management information systems. While the Company's management anticipates no adverse result from an audit, should any costs be found to be improperly allocated to a government agreement, such costs will not be reimbursed, or if already reimbursed, may need to be refunded. If an audit uncovers improper or illegal activities, civil and criminal penalties and administrative sanctions, including termination of contracts, forfeiture of profits, suspension of payments or fines, and suspension or prohibition from doing business with the government could occur. In addition, serious reputational harm or significant adverse financial effects could occur if allegations of impropriety were made against the Company. There currently are routine audits in process relating to government grant revenues.

Note 14. Leases

The Company adopted the new lease accounting standards (Topic 842) on January 1, 2019 and used the effective date as our initial application. The Company used the modified retrospective approach, applying the new standard to all leases existing as of the date of initial application. Consequently, financial information will not be updated, and the disclosures required under the new standard will not be provided for the dates and periods before January 1, 2019. On January 1, 2019, the Company will recognize a ROU asset of $2.3 million and an operating lease liability of $2.4 million.

The new standard also provides practical expedients for an entity's ongoing accounting. The Company has elected the short-term lease recognition exemption for field trial lease agreements. This means, for those leases that qualify, the Company will not recognize ROU assets or lease liabilities. The Company has elected the practical expedient to not separate lease and non-lease components for all of leases.

Note 15. Income Taxes

The components of loss before income taxes are as follows (in thousands):

	Year Ended December 31,	
	2018	2017
Domestic	$ (13,470)	$ (15,681)
Foreign	—	—
Loss before income taxes	$ (13,470)	$ (15,681)

The total income tax expense for the years ended December 31, 2018 and 2017 was $10,000 and $26,000, respectively, and is comprised of current state taxes and foreign taxes withheld by governmental agencies outside of the United States, as follows (in thousands):

	Year Ended December 31,	
	2018	2017
Current:		
Federal	$ —	$ —
State	1	2
Foreign	9	24
Total current tax expense	10	26
Deferred:		
Federal	—	—
State	—	—
Foreign	—	—
Total deferred tax benefit	—	—
Total tax expense	$ 10	$ 26

The Company operates in only one federal jurisdiction, the United States. The following is a reconciliation of the statutory federal income tax rate to the Company's effective tax rate is as follows:

	Year Ended December 31,	
	2018	2017
Expected income tax provision at the federal statutory rate	21.0%	34.0%
State taxes, net of federal benefit	8.5%	2.6%
Change in valuation allowance	(27.3)%	91.4%
Transaction costs	(2.9)%	—
Related offering costs	(1.1)%	—
Excess windfall benefit	1.4%	—
Nondeductible expenses	—	0.1%
Impact of change in federal tax rate	—	(124.6)%
Withholding taxes	(0.1)%	(0.2)%
Other	0.4%	(3.5)%
Income tax provision	(0.1)%	(0.2)%

Deferred income taxes reflect the net tax effects of temporary differences between the carrying amounts of assets and liabilities for financial reporting purposes and the amounts used for income tax purposes, net operating loss carryforwards ("NOLs") and other tax credits. Significant components of the Company's deferred tax assets and liabilities are as follows (in thousands):

	As of December 31,	
	2018	2017
Deferred tax assets:		
Net operating loss carryforwards	$ 42,097	$ 37,498
Unearned revenue	26	783
Stock-based compensation	2,855	2,273
Accrued payroll and benefits	255	51
Research and development credits	171	171
Fixed asset basis difference	114	128
Inventory reserve	508	396
Charitable contributions	3	3
Total deferred tax assets	46,029	41,303
Deferred tax liabilities:		
Common stock warrant liabilities	(1,529)	—
Total deferred tax liabilities	(1,529)	—
Less valuation allowance	(44,500)	(41,303)
Net deferred tax assets	$ —	$ —

Realization of the deferred tax assets is dependent upon future taxable income, if any, the amount and timing of which are uncertain. Accordingly, the net deferred tax assets have been offset by a valuation allowance. The net valuation allowance increased by $3.2 million and decreased by $14.3 million during the years ended December 31, 2018 and 2017, respectively.

On December 22, 2017, the Tax Cuts and Jobs Act (the "Tax Act") was signed into law making significant changes to the Internal Revenue Code. Changes include, but are not limited to, a corporate tax rate decrease from 35% to 21%, effective for tax years beginning after December 31, 2017. We use the asset and liability method of accounting for income taxes. Under this method, deferred tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax basis. Deferred tax assets and liabilities are measured using enacted tax rates expected to apply to taxable income in the years in which those temporary differences are expected to reverse. As a result of the reduction in the U.S. corporate income tax rate from 35% to 21% under the Tax Act, we revalued our ending net deferred tax assets at December 31, 2017, which were fully offset by a valuation allowance. The Company considers the accounting for the Tax Act to be complete.

At December 31, 2018, the Company had federal and state NOLs aggregating approximately $168.6 million and $123.2 million, respectively. At December 31, 2018, the utilization of a portion of our NOLs is subject to an annual limitation under Section 382 of the Internal Revenue Code (IRC). Of the $168.6 million generated, $7.2 million was previously determined as unavailable to be utilized within the carryforward period. Further, the Company may have experienced an ownership change under IRC Section 382 as a result of the common shares issued in connection with the Purchase Agreement in March 2018 or in the June Offering. Such an ownership change could limit the Company's ability to utilize its NOL carryforwards prior to expiration but would not impact the net deferred tax asset recorded given the full valuation allowance. If not utilized, these federal NOLs will begin to expire in 2020 and state NOLs will begin to expire in 2024. IRC Section 382 may also limit NOLs generated in future years.

The Company evaluates deferred tax assets, including the benefit from NOLs, to determine if a valuation allowance is required. Such evaluation is based on consideration of all available evidence using a "more likely than not" standard with significant weight being given to evidence that can be objectively verified. This assessment considers, among other matters, the nature, frequency, and severity of current and cumulative losses; forecasts of future profitability; the length of statutory carryforward periods; the Company's experience with operating losses; and tax-planning alternatives. The significant piece of objective negative evidence evaluated was the cumulative loss incurred through the year ended December 31, 2018. Given this evidence and the expectation to incur operating losses in the foreseeable future, a full valuation allowance has been recorded against the net deferred tax asset. The Company will continue to maintain a full valuation allowance against the entire amount of its net deferred tax asset, until such time as the Company has determined that the weight of the objectively verifiable positive evidence exceeds that of the negative evidence and it is likely that the Company will be able to utilize all of its net deferred tax asset relating to its federal and state NOL carryforwards. Although the Company has established a full valuation allowance on its net deferred tax asset, for Federal tax losses before 2018 and for all state tax losses, it has not forfeited the right to carryforward tax losses up to 20 years and apply such tax losses against taxable income in such years, thereby reducing its future tax obligations. Federal tax losses generated in 2018 and later do not expire. The Company is subject to taxation in the United States and various state jurisdictions. As of December 31, 2018, the Company's tax years for 2000 through 2018 are generally subject to examination by the tax authorities. The years are open back to 2000 to the extent the NOLs being carried forward were generated then.

The Company applies the provisions of ASC 740 related to accounting for uncertain tax positions and concluded there were no such positions associated with the Company requiring accrual of a liability. As of December 31, 2018, the Company has not accrued for any such positions. The Company is currently not under audit for federal or state tax purposes. The Company does not expect a significant change to occur within the next 12 months.

Note 16. Retirement Benefits

The Company has a 401(k) retirement plan (the "Plan") available for participation by all regular full-time employees who have completed three months of service with the Company. The Company established the Plan in 2008. The Plan provides for a discretionary matching contribution equal to 50% of the amount of the employee's salary deduction, not to exceed 3% of the salary per employee. Highly compensated employees are excluded from receiving any discretionary matching contribution. Employees' rights to employer contributions vest on the one-year anniversary of their date of employment. The Company has the option to make discretionary matching contributions. The Company did not make discretionary matching contributions during the years ended December 31, 2018 and 2017.

Note 17. Segment and Geographic Information

Management has determined that it has one business activity and operates in one segment as it only reports financial information on an aggregate and consolidated basis to its Chief Executive Officer, who is the Company's chief operating decision maker.

Revenues based on the location of the customers, are as follows (in thousands):

	Year Ended December 31,	
	2018	2017
United States	$ 1,168	$ 1,588
India	90	1,064
Africa	115	315
France	—	220
Canada	91	181
China	—	586
Belgium	—	72
Total	$ 1,464	$ 4,026

Note 18. Net Loss per Share

Basic net loss per share is calculated by dividing net loss attributable to common stockholders by the weightedaverage number of common shares outstanding during the period and excludes any dilutive effects of stockbased awards and warrants. Diluted net loss per share attributable to common stockholders is computed giving effect to all potentially dilutive common shares, including common stock issuable upon exercise of stock options and warrants. As the Company had net losses for the years ended December 31, 2018 and 2017, all potentially dilutive common shares were determined to be antidilutive.

Securities that were not included in the diluted per share calculations because they would be antidilutive were as follows (in shares):

	Year Ended December 31,	
	2018	2017
Options to purchase common stock	530,044	288,129
Warrants to purchase common stock	2,822,903	66,845
Total	3,352,947	354,974

Note 19. Related Party Transactions

The Company's related parties include Moral Compass Corporation ("MCC") and the John Sperling Foundation ("JSF"). The rights to the intellectual property owned by Blue Horse Labs, Inc. ("BHL") were assigned to its sole shareholder, the John Sperling Revocable Trust ("JSRT") due to BHL's dissolution and then subsequently to the JSF. The JSF is deemed a related party of the Company because MCC, the Company's largest stockholder, and the JSF share common officers and directors.

Transactions with related parties are reflected in the consolidated financial statements under amounts due to related parties. Outlined below are details of agreements between the Company and its related parties:

JSF receives a single digit royalty from the Company when revenue has been collected on product sales or for license payments from third parties that involve certain intellectual property developed under research funding originally from BH. Royalty fees due to JSF were $29,000 and to JSRT $29,000 as of December 31, 2018 and December 31, 2017 and are included in the Consolidated Balance Sheets as amounts due to related parties.

Note 20. Subsequent Event

The Company has reviewed and evaluated subsequent events through April 1, 2019, the date the consolidated financial statements were available to be issued.

Item 9. Changes in and Disagreements With Accountants on Accounting and Financial Disclosure.

None.

Item 9A. Controls and Procedures.

Evaluation of Disclosure Controls and Procedures

As of December 31, 2018, Arcadia's disclosure controls and procedures were evaluated, with the participation of Arcadia's principal executive officer and principal financial officer, to assess whether they are effective in providing reasonable assurance that information required to be disclosed by Arcadia in the reports that it files or submits under the Securities Exchange Act of 1934 is accumulated and communicated to management, including its principal executive officer and principal financial officer, as appropriate, to allow timely decisions regarding required disclosure and to provide reasonable assurance that such information is recorded, processed, summarized and reported within the time periods specified in Securities and Exchange Commission rules and forms. Based on this evaluation, Rajendra Ketkar, Arcadia's principal executive officer, and Matthew T. Plavan, Arcadia's principal financial officer, concluded that these disclosure controls and procedures were effective as of December 31, 2018.

Management's Report on Internal Control Over Financial Reporting

Management is responsible for establishing and maintaining adequate internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)). Arcadia's management, including Rajendra Ketkar, its principal executive officer, and Matthew T. Plavan, its principal financial officer, evaluated the effectiveness of Arcadia's internal control over financial reporting using the framework in Internal Control—Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). Based on this evaluation, management concluded that Arcadia's internal control over financial reporting was effective as of December 31, 2018.

Changes in Internal Control over Financial Reporting

Under the supervision and with the participation of our management, including our Principal Executive Officer and Principal Financial Officer, we conducted an evaluation of any changes in our internal control over financial reporting (as such term is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) that occurred during our most recently completed fiscal quarter. Based on that evaluation, our Principal Executive Officer and Principal Financial Officer concluded that there has not been any change in our internal control over financial reporting during that quarter that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. Other Information.

None.

PART III

Item 10. Directors, Executive Officers and Corporate Governance.

The information required by this item will be contained in our definitive proxy statement to be filed with the Securities and Exchange Commission on Schedule 14A in connection with our 2019 Annual Meeting of Stockholders (the "Proxy Statement"), which is expected to be filed no later than 120 days after the end of our fiscal year ended December 31, 2018, under the headings "Executive Officers," "Election of Directors," "Corporate Governance," and "Section 16(a) Beneficial Ownership Reporting Compliance," and is incorporated herein by reference.

The Company has adopted a written code of business conduct and ethics that applies to our directors, officers, and employees, including our principal executive officer, principal financial officer, principal accounting officer or controller, or persons performing similar functions. A current copy of the code is posed on the Corporate Governance section of our website, which is located at www.arcadiabio.com. If Arcadia makes any substantive amendments to, or grant any waivers from, the code of business conduct and ethics for our principal executive officer, principal financial officer, principal accounting officer, controller or persons performing similar functions, or any officer or director, the Company will disclose the nature of such amendment or waiver on our website or in a current report on Form 8-K.

Item 11. Executive Compensation.

The information required by this item will be contained in Proxy Statement under the headings "Executive Compensation" and "Director Compensation," and is incorporated herein by reference.

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.

The information required by this item will be contained in Proxy Statement under the headings "Security Ownership of Certain Beneficial Owners and Management" and "Equity Compensation Plan Information," and is incorporated herein by reference.

Item 13. Certain Relationships and Related Transactions, and Director Independence.

The information required by this item will be contained in Proxy Statement under the headings "Certain Relationships and Related Party Transactions" and "Corporate Governance," and is incorporated herein by reference.

Item 14. Principal Accounting Fees and Services.

The information required by this item will be contained in Proxy Statement under the heading "Ratification of Independent Registered Public Accounting Firm-Principal Accounting Fees and Services," and is incorporated herein by reference.

PART IV

Item 15. Exhibits, Financial Statement Schedules.

The financial statements schedules and exhibits filed as part of this Annual Report on Form 10-K are as follows:

(a)(1) Financial Statements

Reference is made to the financial statements included in Item 8 of Part II hereof.

(a)(2) Financial Statement Schedules

All other schedules are omitted because they are not required or the required information is included in the statements or notes thereto.

(a)(3) Exhibits

Reference is made to the Exhibit Index accompanying this Annual Report on Form 10-K.

Item 16. Form 10-K Summary.

Not Applicable

Exhibit Index

Exhibit Number	Exhibit Description	Incorporated by Reference				Filed Herewith
		Form	File No.	Exhibit	Filing Date	
3.1	Amended and Restated Certificate of Incorporation of Registrant.	8-K	001-37383	3.1	5/26/2015	
3.2	Certificate of Amendment to the Amended and Restated Certificate of Incorporation of Registrant.	10-Q	001-37383	3.1	8/10/2017	
3.3	Amendment to the Amended and Restated Certificate of Incorporation of Registrant.	8-K	001-37383	3.1	1/23/2018	
3.4	Amended and Restated Bylaws of Registrant.	8-K	001-37383	3.2	5/26/2015	
4.1	Form of Registrant's common stock certificate	S-3	333-224061	4.1	3/30/2018	
4.2	Amended and Restated Stock Purchase Warrant dated December 11, 2013 between the Registrant and Mahyco International Pte Ltd.	S-1/A	333-202124	4.7	4/30/2015	
4.3	Form of Common Stock Purchase Warrant between the Registrant and certain purchasers of its Series D Preferred Stock.	S-1	333-202124	4.8	2/17/2015	
4.4	Form of Common Stock Purchase Warrant	8-K	001-37383	4.1	3/23/2018	
4.5	Securities Purchase Agreement dated as of March 19, 2018, between Arcadia Biosciences, Inc. and each purchaser named in the signature pages thereto	8-K	001-37383	10.1	3/23/2018	
4.6	Form of Registration Rights Agreement	8-K	001-37383	10.2	3/23/2018	
4.7	Form of Securities Purchase Agreement dated as of June 11, 2018, between Arcadia Biosciences, Inc. and each purchaser named in the signature pages thereto	8-K	001-37383	10.1	6/14/2018	
10.1*	Form of Indemnification Agreement between the Registrant and each of its Officers and Directors.	S-1	333-202124	10.7	2/17/2015	
10.2*	2006 Stock Plan, as amended and restated, and form of agreement thereunder.	S-1	333-202124	10.8	2/17/2015	
10.3*	2015 Omnibus Equity Incentive Plan and forms of agreement thereunder.	S-1/A	333-202124	10.9	5/11/2015	
10.4*	2015 Employee Stock Purchase Plan and form of agreement thereunder.	S-1/A	333-202124	10.10	5/11/2015	
10.5*	Executive Incentive Bonus Plan.	S-1/A	333-202124	10.15	5/11/2015	
10.6*	Director Compensation Policy.	10-Q	001-37383	10.16	6/25/2015	

Exhibit Number	Exhibit Description	Incorporated by Reference				Filed Herewith
		Form	File No.	Exhibit	Filing Date	
10.7*	Form of Severance and Change in Control Agreement.	S-1/A	333-202124	10.18	4/6/2015	
10.8	Office Lease dated March 17, 2003 between the Registrant and Buzz Oates LLC as successor to Marvin L. Oates, Trustee of the Marvin L. Oates Trust, as amended.	S-1	333-229047	10.16	12/27/2018	
10.9	Loan and Security Agreement dated December 29, 2015 between the Registrant, as borrower, and Silicon Valley Bank, as lender.	8-K	001-37383	10.1	12/30/2015	
21.1	List of subsidiaries of the Registrant.	S-1	333-202124	21.1	2/17/2015	
31.1	Certification of Principal Executive Officer Pursuant to Rules 13a-14(a) and 15d-14(a) under the Securities Exchange Act of 1934, as Adopted Pursuant to Section 302 of the Sarbanes-Oxley Act of 2002.					X
31.2	Certification of Principal Financial Officer Pursuant to Rules 13a-14(a) and 15d-14(a) under the Securities Exchange Act of 1934, as Adopted Pursuant to Section 302 of the Sarbanes-Oxley Act of 2002.					X
32.1	Certification of Principal Executive Officer Pursuant to 18 U.S.C. Section 1350, as Adopted Pursuant to Section 906 of the Sarbanes-Oxley Act of 2002.					X
32.2	Certification of Principal Financial Officer Pursuant to 18 U.S.C. Section 1350, as Adopted Pursuant to Section 906 of the Sarbanes-Oxley Act of 2002.					X
101.INS	XBRL Instance Document.					X
101.SCH	XBRL Taxonomy Extension Schema Document.					X
101.CAL	XBRL Taxonomy Extension Calculation Linkbase Document.					X
101.DEF	XBRL Taxonomy Extension Definition Linkbase Document.					X
101.LAB	XBRL Taxonomy Extension Label Linkbase Document.					X
101.PRE	XBRL Taxonomy Extension Presentation Linkbase Document					X

* Indicates a management contract or compensatory plan or arrangement.

† Confidential treatment has been requested to certain portions of this exhibit. Omitted portions have been separately filed with the SEC.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, as amended, the Registrant has duly caused this Report to be signed on its behalf by the undersigned, thereunto duly authorized.

ARCADIA BIOSCIENCES, INC.

Date: April 1, 2019

By: /s/ RAJENDRA KETKAR
Rajendra Ketkar
President and Chief Executive Officer
(Principal Executive Officer)

Date: April 1, 2019

By: /s/ MATTHEW T. PLAVAN
Matthew T. Plavan
Chief Financial Officer
(Principal Financial and Accounting Officer)

Each person whose individual signature appears below hereby authorizes and appoints Matthew T. Plavan with full power of substitution and resubstitution and full power to act without the other, as his or her true and lawful attorney-in-fact and agent to act in his or her name, place and stead and to execute in the name and on behalf of each person, individually and in each capacity stated below, and to file any and all amendments to this Annual Report on Form 10-K, and to file the same, with all exhibits thereto, and other documents in connection therewith, with the Securities and Exchange Commission, granting unto said attorneys-in-fact and agents, and each of them, full power and authority to do and perform each and every act and thing, ratifying and confirming all that said attorneys-in-fact and agents or any of them or their or his substitute or substitutes may lawfully do or cause to be done by virtue thereof.

Pursuant to the requirements of the Securities Exchange Act of 1934, as amended, this Report has been signed below by the following persons on behalf of the registrant in the capacities and on the dates indicated.

Name	Title	Date
/s/ RAJENDRA KETKAR **Rajendra Ketkar**	**Director**	April 1, 2019
/s/ KEVIN COMCOWICH **Kevin Comcowich**	**Director**	April 1, 2019
/s/ ALBERT D. BOLLES, PH. D **Albert D. Bolles**	**Director**	April 1, 2019
/s/ ERIC J. REY **Eric J. Rey**	**Director**	April 1, 2019
/s/ LILIAN SHACKELFORD MURRAY **Lilian Shackelford Murray**	**Director**	April 1, 2019
/s/ GREGORY D. WALLER **Gregory D. Waller**	**Director**	April 1, 2019
/s/ AMY YODER **Amy Yoder**	**Director**	April 1, 2019

Exhibit 31.1

CERTIFICATION PURSUANT TO
RULES 13a-14(a) AND 15d-14(a) UNDER THE SECURITIES EXCHANGE ACT OF 1934,
AS ADOPTED PURSUANT TO SECTION 302 OF THE SARBANES-OXLEY ACT OF 2002

I, Rajendra Ketkar, certify that:

1. I have reviewed this Annual Report on Form 10-K of Arcadia Biosciences, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

   (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 27, 2019

By: /s/ RAJENDRA KETKAR
Rajendra Ketkar
President and Chief Executive Officer
(Principal Executive Officer)

Exhibit 31.2

CERTIFICATION PURSUANT TO
RULES 13a-14(a) AND 15d-14(a) UNDER THE SECURITIES EXCHANGE ACT OF 1934,
AS ADOPTED PURSUANT TO SECTION 302 OF THE SARBANES-OXLEY ACT OF 2002

I, Matthew T. Plavan, certify that:

1. I have reviewed this Annual Report on Form 10-K of Arcadia Biosciences, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

   (a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

   (b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

   (c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

   (d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

   (a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

   (b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 27, 2019

By: /s/ MATTHEW T. PLAVAN
Matthew T. Plavan
Chief Financial Officer
(Principal Financial Officer)

Exhibit 32.1

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350, AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of Arcadia Biosciences, Inc. (the "Company") on Form 10-K for the year ended December 31, 2018 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that:

(1) the Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: March 27, 2019

By: /s/ RAJENDRA KETKAR
Rajendra Ketkar
President and Chief Executive Officer
(Principal Executive Officer)

Exhibit 32.2

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350, AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of Arcadia Biosciences, Inc. (the "Company") on Form 10-K for the year ended December 31, 2018 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), I certify, pursuant to 18 U.S.C. § 1350, as adopted pursuant to § 906 of the Sarbanes-Oxley Act of 2002, that:

(1) the Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) the information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Date: March 27, 2019

By: /s/ MATTHEW T. PLAVAN
Matthew T. Plavan
Chief Financial Officer
(Principal Financial Officer)