

Hawaii's Seed Crop Industry: Current and Potential Economic and Fiscal Contributions

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EXECUTIVE SUMMARY

The research objective of this study is to update our 2009 study of the Hawaii seed crop industry's economic and fiscal contributions to the State of Hawaii. To this end we have provided:

- Background information about the technology used by the industry locally and internationally,
- Details of Hawaii's seed crop industry with comparisons to other Hawaii sectors and subsectors,
- The economic contributions of the seed crop industry.

Our primary research conclusion is that Hawaii's seed crop industry makes significant ever increasing economic and fiscal contributions to the state's economy generally, and most particularly to the agriculture, life sciences and high technology subsectors. These contributions are most significant in rural Hawaii relative to other economic subsectors. Seed crop industry economic contributions to the state should continue to increase, albeit at a slower rate than historically.

Background Information

The Hawaii seed crop industry arrived in Hawaii 50 years ago when several seed crop companies first located here. Hawaii offered and continues to offer a unique factor set, including:

- Year-round growing conditions allowing up to four crop cycles per year
- Availability of a highly skilled agricultural workforce
- Availability of land and water
- A stable political and economic environment.

This factor combination gives Hawaii a competitive advantage over U.S. mainland and international locations for a seed crop industry. Currently, 45 companies comprise the industry, some of which are international leaders in the advancements of agricultural science. Seed crop farms are located on Oahu, Maui, Kauai and Molokai. These farms use both conventional as well as biotech plant breeding methods to grow seed crops. The primary seed crop grown in Hawaii is corn, all of which is exported to both North and South America for further development and ultimate worldwide distribution. In the complex system of worldwide food production, the objective of the stop in Hawaii is improved and increased crop production.

The seed crop industry uses conventional plant breeding techniques to a significant extent. Because of limitations of this method the industry also uses genetic engineering technology. This technology allows the transferability of specific traits to plants with the simultaneous exclusion of undesirable traits. Because of their preciseness, genetic engineering plant breeding practices can be regarded as a significant technological advancement over conventional plant breeding practices. Traits most commonly

engineered into plant varieties in Hawaii include increased insect and disease resistance, resistance to common agricultural herbicides and increased yields.

The Hawaii Seed Crop Industry

Industry Growth

The seed crop industry in Hawaii currently consists of 10 farms that cultivate seed corn, soybean, wheat, sunflower, and other seed crops. Seed corn comprised 95.6% of the value of the seed crop industry in 2011. Hawaii's seed crop industry has grown dramatically. Since its inception, the Hawaii seed crop industry grew almost 54,000% at an average annual rate of 15.4%. Since 2000 the industry grew 548% at an average annual rate of 18.5%. The authors are not aware of any other Hawaii economic sector or sub-sector exhibiting such growth.

It is noteworthy that our seed crop industry forecast growth in 2009 of 65.4% from 2008 to 2012 was exceeded by actual industry growth of 72.2%. While seed crop industry growth has been stellar historically, it appears to be slowing as this industry matures and possibly due to the worldwide economic slowdown since 2008. Growth will continue given continued operating expenditures at a current level of \$243 million and anticipated capital investment in Hawaii averaging \$25 million over the next 10-years.

Hawaii's seed crop industry average annual value growth since 1968 (15.4%) greatly exceeds Hawaii's general economic growth as measured by GSP (7.1%). This growth rate difference is even more dramatic since 2000 when seed crop industry growth equaled 18.5% versus GSP growth of 4.5%. More significant is the seed crop industry's contribution to Hawaii's agricultural sector. At current farm value levels, the Hawaii seed crop industry's value contribution to the agricultural sector makes it:

- The largest agricultural commodity with a value contribution that exceeds the contribution of sugar, the second largest commodity, by more than 200%.
- The fastest growing agricultural commodity.
- An agricultural subsector providing almost 34% of the total value of all Hawaii agricultural crops, 39% of total Hawaii crop value and 44% of total Hawaii diversified agriculture.

The seed crop industry's average annual growth rate since 2000 of 18.5% and rank as the number 1 agricultural and diversified agricultural crop in Hawaii stands in marked contrast to growth rate comparisons.

- Major Hawaii agricultural subsector average annual growth rates (crop rank) are:
 - Total Hawaii agriculture 3.2%
 - Sugar 2.1% (2) per year
 - Pineapple -3.6% (3) per year (last reporting year was 2007)
- Major Hawaii diversified agricultural subsector crop annual growth rates (diversified agriculture rank) are:
 - Diversified agricultural total 4.0% per year
 - Nursery 1.0% (2) per year

- Coffee 4.6% (6) per year
- Macadamia nuts 2.4% (5).

A footnote to the existence and growth of the Hawaii seed crop industry and its contribution to the agricultural sector is that this industry has received no governmental support in the form of subsidies, targeted tax credits, tax breaks, etc. to locate and operate in Hawaii. The contribution to the Hawaii seed crop industry is solely due to Hawaii's natural resource competitive advantage.

Jobs

Job Number and Distribution: As of its most recent reporting, the Hawaii seed industry employs 1,397 individuals. Relative to Hawaii comparatives the seed crop industry:

- Has a significantly higher proportion of agricultural-related jobs (81.6% industry-wide, 80.0% for Oahu and 82.9% for the neighbor islands) than Hawaii comparatives (1.2% statewide, 0.4% for Oahu and 3.4% for the neighbor islands);
- Has a significantly higher proportion of professional-related jobs (15.9% industry-wide, 19.3% for Oahu and 13.1% for the neighbor islands) than Hawaii comparatives (12.5% statewide, 13.7% for Oahu and 9.2% for the neighbor islands).

Job Growth: Seed crop industry job growth since the authors' 2006 study has been significant, especially when contrasted with statewide employment changes. However, since our 2009 study, seed industry job growth has declined.

- Seed crop industry
 - Total job growth 2006-2012 = 29.7%
 - Total job growth 2009-2012 = -9.4%
- Hawaii State
 - Total job growth
 - 2006-2012 = -5.12%
 - 2009-2012 = -7.1%
 - Ag sector job growth
 - 2006-2012 = -6.2%
 - 2009-2012 = 20.0%

The seed crop industry job increases have occurred in a Hawaii employment environment that has at best been lackluster since 2005, although the downward trend in statewide agricultural appears to be reversing. In contrast, seed crop industry for recent years shows a leveling of its historic upward trend.

At current employment levels, the seed crop industry percentage of all agricultural jobs equals:

- 20.2% of statewide agriculture jobs
- 27.8% of Oahu agricultural jobs
- 12.4% of Neighbor island agricultural jobs

Employee Compensation

Earnings: Overall average earnings for the seed crop industry are 11.1% greater than the statewide average. The seed crop industry pays a higher than average wage scale to its workers in all occupations than one would expect based on statewide and per island averages except business & financial occupations and office & administrative, which make up an insignificant percentage of total industry jobs. The percentage by which seed crop industry pay exceeds statewide average is:

- 34.2 for management and professional jobs
- 35.9% for farm labor jobs

The seed crop industry's high relative wage scales contribute to economic diversification, which is greater for the neighbor islands than Oahu given the relatively higher neighbor island wage scales for management & professional workers.

Benefits: In spite of paying a higher wage, overall the seed crop industry provides a benefits package the value of which well comports with benchmarks in percentage terms. In dollar terms, seed crop benefits packages are higher than benchmarks because the benefits percentage is multiplied by a higher wage.

In sum, seed crop industry compensation packages are more generous than Hawaii benchmark comparisons.

Economic Contributions of Hawaii Seed Industry

Direct Contributions

The total economic impacts (i.e. annual from operating expenditures and CAPEX) of the Hawaii seed industry to the state economy are the following.

- Seed crop industry direct annual contributions to the Hawaii economy from annual expenses equals \$239.4 million. This is 33.3% of total direct annual contributions to Hawaii's economy from all Hawaii agriculture.
- Seed crop industry labor income equals to \$69.2 million. This is 28.1% of the total labor income of Hawaii's agricultural sector.
- Total Hawaii employment attributable to direct expenditures of the seed industry equals 1,397, which is 16.5% of the total jobs in agriculture.
- Industry CAPEX over the next 10 years is estimated to be 37.7% less than the previous 10 years. Nonetheless, it is yet estimated to be \$25 million per year 65.3% of which is estimated to occur on the neighbor islands. This direct seed crop industry expenditure generates \$7.1 million in labor income and 96 jobs.
- On a sub-regional basis (i.e. Molokai or West Kauai) seed company expenditures and jobs as a percentage of local totals have a much larger economic impact than occurs relative to the comparisons made herein. This is even more significant

when discussing the agricultural sector, which generally comprises a much larger percentage of total economic activity and employment in Hawaii rural areas.

Indirect and Induced Impacts and Total Economic Impacts

Besides the direct impact, the Hawaii seed industry (direct) operating and capital expenditures create ripple (i.e. multiplier) effects in the economy by generating revenues, jobs, salaries and taxes in the form of indirect and induced impacts. The seed crop industry's direct annual contributions from annual expenditures result in indirect/induced impacts and total impacts of:

- \$286.5 million indirect/induced output with total annual output attributable to the Hawaii seed crop industry from annual expenses of \$550.1 million, which is 30.9% of the total annual output of the Hawaii agricultural sector;
- \$186.5 million indirect/induced labor income with total annual labor income attributable to the Hawaii seed crop industry from annual expenses of \$262.9 million, which is 28.1% of the total annual labor income generated by the Hawaii agricultural sector;
- 1,034 indirect/induced jobs with total annual jobs attributable to the Hawaii seed crop industry from annual expenses of 2,527, which is 21.6% of total Hawaii agricultural sector jobs.
- The economic impact of the seed crop industry we measure is conservative given the high likelihood of the industry contributions not measured in our study in the form of an increased knowledge base for Hawaii's life sciences sector stimulating more local investment in research & technology, economic activity, related labor income and job creation, and an increased tax base.

Tax Revenue Contributions

On an annual basis, the Hawaii seed industry activities currently generate \$29.4 million tax revenues to the State. This represents an increase of over 100% seed crop industry tax contributions measured in 2009.

Seed Crop Industry Contribution To State Public Policy Objectives

By its mere existence the seed crop industry contributes to generally-stated Hawaii public policy objectives which includes the following:

- Economic diversification not only statewide but in particular on the neighbor islands where economic diversification is less than on Oahu;
- Creating jobs in a green industry, agriculture;
- Maintaining prime agricultural lands in agricultural use with little if any incentive to convert these lands to alternative uses due to their profitable use by the seed crop industry;
- Creating high-tech jobs.

Slightly more than 20 years ago Hawaii's agricultural sector contributed 2% of Hawaii's GSP. This percentage currently and in our 2009 study is less than 1%. This declining

trend shows no sign of abating in any significant way. The Hawaii seed industry has mitigated the downward trend of agricultural as a contributor to Hawaii economic activity maintaining this source of statewide as well as per county economic diversification. While seed crop industry growth and job creation may be leveling as the industry matures, it yet remains the most significant contributor as an individual crop to the agricultural sector of Hawaii. Without the seed crop industry, Hawaii's agricultural sector would be dramatically different than currently. Specifically,

- Without the seed crop industry the Hawaii's diversified agricultural sector would decrease by 45%;
- Without the seed crop industry the Hawaii's farm sector would decrease by more than one third;
- Neighbor island decreases in the diversified agricultural sector and overall for all farms would be much more significant than statewide averages.

It merits re-acknowledgement that the seed crop industry contributions to achieve public policy goals are at no cost to the State. Rather this contribution is a natural response by market participants to put to profitable and productive use Hawaii natural resources that otherwise could become idle, thereby making no economic, public policy or other contribution to the State.

FOREWORD

This study was commissioned by the Hawaii Farm Bureau Federation with funding provided by the Hawaii Crop Improvement Association (HCIA). The Hawaii Field Office Management Team of the U.S. Department of Agriculture's National Agriculture Statistics Service (USDA-NASS) led by Director Mark Hudson collected Hawaii seed industry data. This approach assured non-disclosure of firm-specific, proprietary data and removed any data biases. Seed company data reported in the study represents industry totals with no firm or island-specific data disclosed, a detail confirmed by USDA-NASS personnel previous to public release of this study.

The authors wish to thank the organizations and individuals noted for their assistance and contribution to this study.

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STUDY RESULTS

I. Introduction

According to the University of Hawaii's College of Tropical Agriculture's (CTAHR) publication on 'Corn Production in the Tropics: The Hawaii Experience,' the origin of the Hawaii seed crop industry can be traced to 1966. Since this time, this industry has the most significant agricultural industry in the State. Although the year round growing conditions is one of the major reasons for its success, economic production of seed corn has been made possible due to superior adapted varieties, competent farmers, availability of excellent land and water, a favorable climatic regime that permitted multiple generations of seed crops per year and a reliable market. Other favorable factors included the state's stable political and economic environment.

The not-for-profit trade association the Hawaii Crop Improvement Association (HCIA) represents the Hawaii seed industry. HCIA membership includes companies such as BASF, Monsanto, DowAgro Sciences, DuPont/Pioneer Hi-Bred International, and Syngenta that own and operate seed farms on various isles [28]. They are a part of Hawaii's life sciences industry that now includes over 125 companies. The life sciences companies are spread over the agricultural, nutraceutical, environmental bioremediation, human therapeutics and the marine sciences sub sectors. Other significant contributors to Hawaii's life sciences industry are the Hawaii Agricultural Research Center and CTAHR.

Seed crop industry research activity has included crop protection against fungi, viral and bacterial diseases [3]. Other important research activities have focused on improving product quality (seven) while improving agronomic characteristics has been the target in two of the research activities over the past 15 years. HCIA member companies use both conventional as well as biotech plant breeding methods to grow the seed crops. Besides corn, other seeds cultivated include soybeans, sunflower, wheat and rice varieties. Of the other six important and high valued agricultural crops in the state: pineapple, sugarcane, coffee, papaya, dendrobiums and anthuriums, only papaya has commercial biotech varieties in production [3].

The Hawaii Agriculture Research Center (HARC), which was previously the Hawaii Sugar Planter's Association (HSPA), does high technology and biotech research. From sugarcane research it has expanded its scope to do research on forestry, coffee, forage, vegetable crops, tropical fruits and diversified crops. The Center specializes in horticultural crop research on various aspects involving agronomy and plant nutrition, physiology, breeding, genetic engineering and tissue culture and the control of diseases and pests. Their genetic engineering projects are limited to sugarcane, pineapple, coffee and papaya.

CTAHR is the third contributor to Hawaii biotechnology research. In 2011 approximately 2 percent of the college's research efforts involved genetic engineering and about 5-6 percent focused on agricultural crops. CTAHR's most notable achievement in biotechnology has been the development of the genetically engineered papaya called Rainbow. Japan approved importation of Hawaii's Rainbow papaya at the

end of 2011. This event will assist Hawaii's papaya industry to reclaim its export market worth \$15 million in the mid-1990s.

Among other biotech projects at CTAHR holding future promise are nematode resistance, pineapple mealy bug with virus resistance, control of flowering and fruit ripening, transgenic banana plants, reduction of mimocene production to improve the forage quality of *Leucaena leucocephala* and introduction of disease resistance genes from rice into the Chinese 'Bun Long' taro variety which was recently completed. Transgenic pineapple and taro are not in the field trial stage but banana has progressed to small scale field trials but no GM plants have been released to farmers.

The Hawaii seed crop industry production occurs on 10 separate farms cultivating 5,625 acres in the state. Of this acreage 1,570 were used for nursery, 3,920 acres for seed increase, and 135 for grow-out or observation. Farms are located on Oahu, Mau, Kauai and Molokai. While total current acreage decreased from its 2009/10 peak (6,500), total out shipments of seed peaked at 12,540,000 valued at \$243 million for Hawaii operations, the highest seed crop production and value recorded to date. Seed corn accounts for 95 percent of this total value.

Due to its Hawaii research and production, the seed crop industry not only contributes to economic growth but also the creation of high-tech jobs. Approximately, 14 percent of the jobs in the industry are high tech jobs as compared to 5 percent state wide.

The Hawaii seed crop industry exports its production to both North and South America [44]. The seeds exported from Hawaii do not immediately enter production agriculture. They are destined for further propagation and testing in mainland fields. The seeds comprise the parent stock that farmers will utilize in the subsequent two to three years. During its development phase in Hawaii, the seed corn picks up the latest stock of genetic improvements developed by the industry. The seed corn is destined for worldwide distribution making Hawaii a contributor to the global food production complex.

The focus of this study is Hawaii's seed crop industry. The industry has continued to grow but at a decreasing rate the last several years with industry maturation. Nonetheless, the industry yet remains a significant driver of the life sciences biotechnology industry in Hawaii and a significant contributor to Hawaii's agricultural sector [1, 2]. This research updates our 2009 study entitled "Hawaii's Seed Crop Industry: Current and Potential Economic and Fiscal Contributions." The update focuses only on quantifiable economic aspects of this industry.

II. Approach

As with our earlier study, the focus of our current research is to capture and update the economic value of the contributions of the seed crop industry to Hawaii's economy. The present study does not include the contributions of agricultural technology crops such as pineapple, sugarcane, papayas, coffee, macadamia nuts, dendrobiums, anthuriums and other floricultural products. The value of the economic contributions of the seed crop industry to the Hawaii economy is estimated using proprietary data and the 2007 state input-output tables. Through this analytic process, we examine and analyze the growth

of the seed crop industry, employment generated and growth contrasted with other economic sectors, paid compensation including benefits, and tax contributions of the industry. Our estimate of the economic contributions to the state economy is based on the operational expenditures of the seed crop industry as well as projected capital expenditures over 10 years.

As noted, approximately half of seed crop acreage utilizes conventional breeding practices while the other half involves genetic engineering breeding methods. It is not possible to estimate economic contributions to the state economy by each because producer accounting practices do not allocate costs separately by breeding method. Thus, the study estimates the economic contributions of the seed crop industry with no allocation of values by breeding method [1, 2].

III. The Hawaii Seed Crop Industry

Hawaii's Competitive Advantage

Hawaii's climate continues to provide a competitive edge in attracting seed companies. The all-year growing climatic condition facilitates seed producer cultivation of three to four crops cycles per year. This expedites the development of new plant varieties with desirable traits fairly quickly. With an existing sophisticated science and technology infrastructure, a favorable climatic regime, and a stable economic and political environment, Hawaii possesses a competitive advantage over other U.S. mainland and international locations for the seed crop industry.

Seed Industry and Growth

Seed corn comprises approximately 95% of the value of the seed crop industry in 2011/12. Hawaii seeds developed are bred for herbicide and insect resistance.

Industry Growth: Hawaii's seed crop industry has grown dramatically since commencing operations in Hawaii.

- Total seed crop acreage increased from 405 acres in 1968-69 to 5,625 acres in 2011-12. This is:
 - A total increase of almost 1,289%
 - An average annual increase of 6.2%.
- The total outshipments of seeds increased from 130,000 pounds in 1968-69 to 12,540,000 pounds in 2011-12. This is:
 - A total increase exceeding 9,500%
 - An average annual increase of 10.9%.
- Between 1968-69 and 2011-12 the total value of seed crops increased from \$450,000 to \$242,970,000. This is:
 - A total increase of almost 54,000%
 - An average annual increase of 15.4%.

This data indicates that Hawaii's seed industry has experienced exponential growth over its Hawaii existence. Observing the growth in value of the Hawaii seed industry best

shows this dramatic growth. Figure 1 charts the value of Hawaii seed industry since its inception.

Figure 1: Hawaii Seed Industry Value [28]

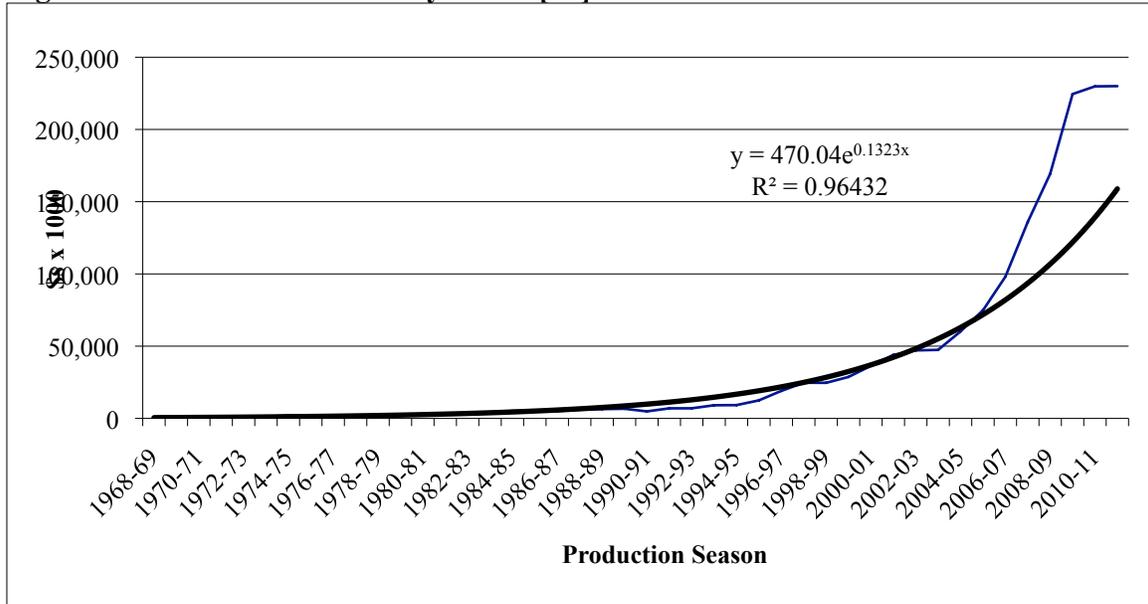


Chart Note: The vertical axis measures seed industry annual Hawaii expenditures and the horizontal axis the production year of the expenditure. The **bold line** represents the (exponential) trend of the reported industry value shown by the non-smoothed line.

Average annual industry value growth since 2000 equals 18.5% exceeding the longer-term average annual growth rate reported above. However, Figure 1 suggests that seed crop industry growth may be slowing as industry value growth since 2009-10 has only been about 1%. It remains to be seen if the slowdown is due to the sluggish economic conditions since 2008 and if so industry growth resumes as historically with improving general economic conditions. Alternately, it may reflect a maturing of the industry with a much lower than historic growth rate moving forward.

It is noteworthy that a seed crop industry forecast based on the industry historic value chart in 2008 forecast growth of 65% from 2008 to 2012, which was slightly exceeded by actual industry growth. Actual seed crop value shipments increased 72% from 2007-08 to 2011-12. The authors are unaware of any other industry or economic subsector in Hawaii exhibiting such growth.

Seed Crop Industry Growth and Value Contrasted

Contrasting Hawaii’s seed crop growth rates and value with other Hawaii economic indicators places the industry in perspective.

- The broadest measure of economic growth in the State is Hawaii Gross State Product (GSP). GSP growth was:
 - 7.2% or 47% of the seed crop industry's growth from 1968-2012

- 4.9% or 26% of the seed industry's growth from 2000-2012.
- Growth of Hawaii's agricultural sector was 3.0% or 16.5% of the seed crop industry's growth from 2000-2012.
- At current farm value levels, the Hawaii seed crop industry's value contribution to the Hawaii agricultural sector make it:
 - The largest agricultural commodity with a value contribution that exceeds the contribution of sugar, the second largest commodity, by more than 200%.
 - The fastest increasing agricultural commodity.
 - An agricultural subsector providing almost 34% of the total value of all Hawaii agricultural crops, 39% of total Hawaii crop value and 44% of total Hawaii diversified agriculture.

In contrast to the growth rates of other agricultural subsectors in Hawaii, which have been flat or declining, the seed crop industry has experienced exponential growth as noted. Figures 2 and 3 illustrate the contrasts.

Figure 2 shows the value of the major Hawaii agricultural subsectors over the period. In average annual percentage terms two of three subsectors have been in steady decline and the third has increased at a tepid pace. The average annual growth rates are:

- Sugar -4.2% per year (the "....." line in Figure 2)
- Pineapple -1.2% per year (the "___" line in Figure 2)
- Diversified agricultural less seed crops 2.7% per year (see "----" line in Figure 2).

Figure 2: Farm Value (x1000) of Major Hawaii Agricultural Subsectors

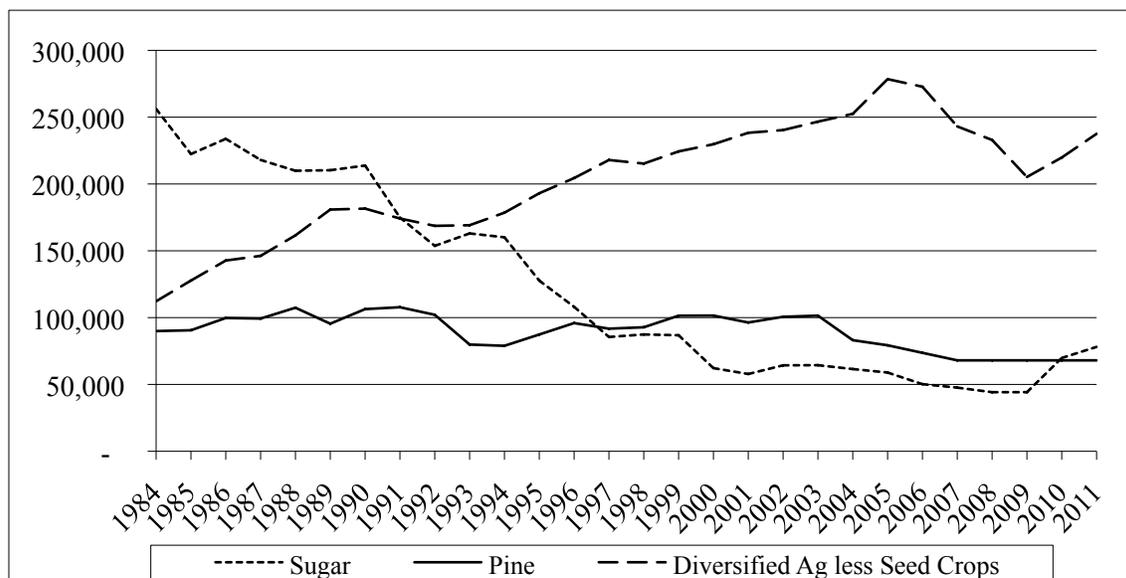


Figure 3 shows the value of the major Hawaii agricultural subsectors over the period. The seed crop industry not only is the largest agricultural subsector but currently comprises 34% of the total value of all Hawaii agricultural crops, 39% of total Hawaii

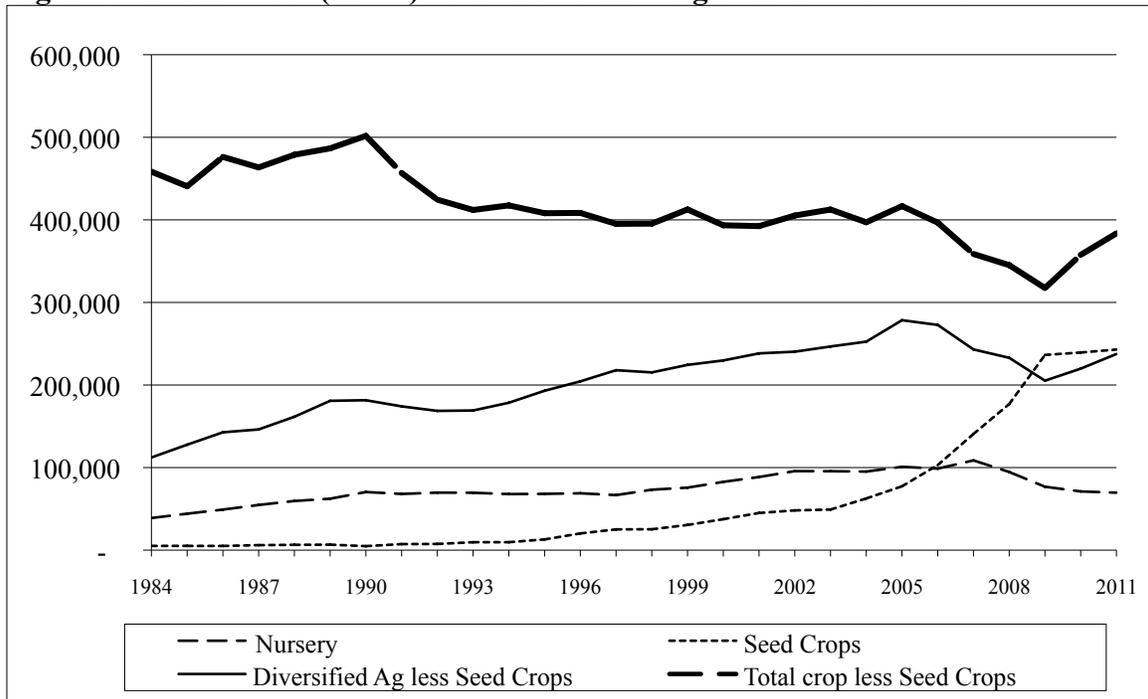
crop value and 44% of total Hawaii diversified agriculture. The seed crop industry has been the largest agricultural subsector since 2005/06.

Of the three reported diversified agricultural subsector categorizations, seed crops by a factor of more than five have the largest average annual growth rate from 1984 to 2012. The various growth rates are:

- Nursery 2.1% per year (the "___" line in Figure 3)
- Seed crops 14.8% per year (the "....." line in Figure 3)
- Diversified agricultural less Seed Crops 2.7% per year (see "___" line in Figure 3)
- Total Crop less Seed Crops -0.6% (see "___" line in Figure 3).

The primary reason Hawaii’s diversified agricultural subsector overall has experienced positive growth since 1984 is due to the existence of the seed crop industry. More generally, without the seed crop industry, Hawaii’s total crop value would have decreased at an average annual rate of 0.6%. With the seed crop industry, Hawaii’s total crop value increased at an average annual rate of 1.1% from 1984 to 2011. Unquestionably, the Hawaii seed crop industry is and has been a significant contributor to the agricultural sector of the economy [1, 2]. At a minimum, this contribution should continue assuming no change in the status quo from what has occurred historically.

Figure 3: Farm Value (x1000) of the Diversified Agriculture Subsectors



The Hawaii seed crop industry contribution to the agricultural sector required no governmental support in the form of subsidies, targeted tax credits, tax breaks, etc., to locate and operate in Hawaii. This contribution is solely due to Hawaii’s natural resource competitive advantage and ability to generate three to four crop cycles per year for

research. Seed crop industry businesses have prospered as attested to by the growth of the industry with consequent economic benefits to Hawaii's agricultural sector and the State generally.

Jobs

Job Number and Distribution: As of its most recent reporting for this analysis, the Hawaii seed industry employs 1,397 individuals. The neighbor island proportion of jobs is 55.2% of total seed industry jobs. The distribution of seed crop industry jobs across occupational categories per island with the corresponding distribution for Hawaii comparatives as follows:¹

- Management & Professional²
 - Seed crop industry
 - Industry-wide 15.9%
 - Oahu = 19.3%
 - Neighbor islands = 13.1%
 - Hawaii comparatives
 - Statewide average = 12.5%
 - Oahu = 13.7%
 - Neighbor islands = 9.2%
- Agriculture-related
 - Seed crop industry
 - Industry-wide 81.6%
 - Oahu = 80.0%
 - Neighbor islands = 82.9%
 - Hawaii comparatives
 - Statewide average = 1.2%
 - Oahu = 0.4%
 - Neighbor islands = 3.2%

Noteworthy observations of the distributions are the following.

- The seed crop industry:
 - Not unexpectedly, has a significant majority of jobs in the agricultural sector industry-wide, for Oahu and for the neighbor islands;
 - Oahu has a greater portion of management & professional-related jobs than the neighbor islands and a lower relative portion of agricultural jobs;
- Relative to Hawaii comparatives the seed crop industry:
 - Has a significantly higher proportion of agricultural-related jobs;
 - Has a higher proportion of management & professional-related jobs.

¹ Two other occupational categories were reported by the industry, Business & Finance and Office and Administrative. No reporting or comparative analysis is presented as collectively total jobs in these categories make up an insignificant percentage of the total seed company jobs.

² This occupational category includes research and science occupations reported separately in our 2009 study.

Job Growth: A significant observation related to employment is the increase in seed crop industry jobs since the authors' 2006 study, especially when contrasted with statewide employment changes.³

- Seed crop industry
 - Industry-wide = 29.7%
 - Oahu = 317.3%
 - Neighbor Island = -16.8%
- Hawaii State
 - Statewide, Oahu and the neighbor islands = -2.8%.

While seed crop job creation performance has been exceptional measured from 2006, since our 2009 study the industry job performance more closely parallels what has occurred statewide.

- Seed crop industry total job change since 2008
 - Industry-wide = -9.4%
 - Oahu = 4.0%
 - Neighbor Island = -37.4%
- Hawaii benchmark total job change since 2008
 - Statewide = -7.1%
 - Oahu = -1.5%
 - Neighbor Island = -19.7%

- Seed crop industry management & professional job change since 2008
 - Industry-wide = 22.4%
 - Oahu = 1.7%
 - Neighbor Island = -64.8%
- Hawaii benchmark management & professional job change since 2008
 - Statewide = -1.3%
 - Oahu = 1.1%
 - Neighbor Island = 2.8%

- Seed crop industry agriculture job change since 2008
 - Industry-wide = -12.8%
 - Oahu = 8.7%
 - Neighbor Island = -24.5%
- Hawaii benchmark agriculture job change since 2008
 - Statewide = 20.0%
 - Oahu = 20.0%
 - Neighbor Island = 22.6

³ It merits clarification in making the comparisons that the data used in our current study and in our 2006 study was gathered for the specific purposes of these studies. The 2006 industry jobs data that we used represented what was current at the end of 2005. The current study uses data collected in 2012 and thus can be considered current jobs data.

Seed crop job growth slowing is consistent with declining acreage of 13.5% in seed crops since 2009 when the industry reached its peak acreage. Declining industry job growth may also reflect some consolidation of operations as the industry matures. Nonetheless, seed crop industry jobs yet make up a significant percentage of agricultural jobs in Hawaii. At current employment levels, the seed crop industry percentage of all agricultural jobs equals:

- 20.2% of statewide agriculture jobs
- 27.8% of Oahu agricultural jobs
- 12.4% of Neighbor island agricultural jobs

Employee Compensation:

Earnings: Hawaii seed crop industry most recently reported annual earnings per occupational category as follows.

- All job average
 - Industry-wide average = \$49,566
 - Management & Professional = \$121,603
 - Agriculture sector average = \$35,453
- Neighbor Island
 - Overall average = \$51,160
 - Management & Professional = \$155,569
 - Agriculture sector average = \$34,625
- Oahu
 - Overall average = \$47,604
 - Management & Professional = \$93,251
 - Agriculture sector average = \$36,509

Benchmark in the State of Hawaii comparisons across the occupations noted are:

- All job average⁴
 - Statewide average = \$44,600
 - Management & Professional = \$90,610
 - Agriculture sector average = \$26,080
- Neighbor Island⁵
 - Overall average = \$40,690
 - Management & Professional = \$84,130
 - Agriculture sector average = \$24,700
- Oahu⁶
 - Overall average = \$45,990
 - Management & Professional = \$92,690
 - Agriculture sector average = \$27,830

⁴ See http://stats.bls.gov/oes/current/oes_hi.htm

⁵ See http://stats.bls.gov/oes/current/oes_1500001.htm

⁶ See http://stats.bls.gov/oes/current/oes_26180.htm#39-0000

However, measured, seed crop industry earnings exceed Hawaii benchmark comparisons. This is most significantly the case for the neighbor islands where industry earnings exceed neighbor island comparisons by:

- 25.7% overall
- 84.9% for management & professional jobs
- 40.2% for agriculture jobs

Overall and most particularly for the neighbor islands, it is exceptional given the much higher percentage of seed crop industry employees in agriculture-related jobs that the industry's average earnings so significantly exceed the statewide average. Agricultural jobs are among the lowest paid of all employment sectors of the economy, as exemplified above when comparing earnings in the agricultural sector to other occupation earnings. Significantly for the agriculture sector, the seed crop industry not only for the neighbor islands but also Oahu pays a significantly higher wage than average.

Aside from the direct economic contribution to the State due to the seed crop industry high relative wage scales, such wage scales also attract professionals, most particularly high-tech workers, which contribute to economic diversification. This contribution is not only to statewide economic diversification, but also within state due to the proportionately higher-than-Oahu wages received by the less well-diversified neighbor islands in the professional category.

Benefits: The seed crop industry benefits⁷ as a percentage of earnings are as follows.

- All workers
 - Industry-wide = 28.7%
 - Oahu = 29.3%
 - Neighbor Islands = 28.2%
- Management & professional
 - Industry-wide = 28.3%
 - Oahu = 29.7%
 - Neighbor Islands = 27.2%
- Agriculture workers
 - Industry-wide = 29.1%
 - Oahu = 29.2%
 - Neighbor Islands = 29.1%

Hawaii comparisons are not available. However, the Bureau of Labor Statistics publishes benefits data for all workers and specific occupational averages.⁸ Several of these include for the following.

⁷ Benefits values include: insurance, retirement & savings and legally required.

⁸ See: <http://www.bls.gov/news.release/ecec.t05.htm>

Subtracted from the reported total benefits value is “paid leave” and “supplemental pay” to make the benchmark comparable to the seed crop industry.

- All workers private sector = 28.4%
- Management & professional = 25.7%
- Agriculture – there are no exclusive reporting categories for this occupation.

In spite of paying a higher wage, overall the seed crop industry provides a benefits package the value of which comports well with benchmarks. Multiplying this benefits percentage times the higher industry wage scale results in a seed crop industry benefits package dollar value that exceeds benchmark averages.

IV. Economic Contributions of the Hawaii Seed Crop Industry

Unlike most other commodities that are directly sold where produced, seed produced in Hawaii is not sold in Hawaii. Hawaii's role is research and development of new seed hybrids and varieties that are produced and sold to farmers worldwide. Thus as noted, the seed industry's Hawaii expenditures, not sales, measure the (direct) transactions of this industry. To quantify the total economic impact of the seed industry in Hawaii requires not only measuring the value of these direct transactions but also indirect and induced transactions attributable to the industry.

Direct Impact

The direct impact of the Hawaii seed industry is the economic impact attributable to the firms that make up the industry through their (direct) operating expenditures for employees and other expenditures related to research and development and growing seed in Hawaii, and the industry's capital expenditures (CAPEX) within the State.⁹ Table 2 shows direct impact amounts of the industry.

Highlights from the data presented in Table 1:

- Seed firms have operating expenditures totaling \$239.4 million
 - These expenditures exceed those reported in our 2009 study by 63.7%
 - This expenditure level equals 33.3% of the total expenditures of Hawaii's agricultural sector.¹⁰
- Seed crop labor income is \$69.2 million (29.0%)
 - Current labor income exceeds that reported in our 2009 study by 13.6%
 - Statewide earning increased of 4.3% over the same period
 - Agriculture earnings decreased 0.9% over the same time period¹¹
 - Seed crop industry agriculture labor income equals 28.1% of the total labor income of Hawaii's agricultural sector.¹²

⁹ The 2007 Input-Output multiplier used to estimate the job creation from seed crop industry annual CAPEX expenditures is the average of the multipliers for: agriculture, mining & construction, real estate and rentals, and professional services.

¹⁰ According to the Hawaii Statistics of Agriculture, the 2011 total output of Hawaii's agricultural sector equals \$719.5 million.

¹¹ http://stats.bls.gov/oes/2009/may/oes_hi.htm#45-0000 and http://stats.bls.gov/oes/current/oes_hi.htm#45-0000

¹² UHERO (<http://uhero.prognoz.com/GraphR.aspx>) reports \$287.25 million in farm earnings for 2011.

- The seed firms employ 1,397 workers for operating activities of which 1,140 are classified as agriculture jobs, which equals 16.5%.
- While estimated industry CAPEX over the next 10 years is less than the previous 10-year amount, the current 10-year forecast seed crop industry CAPEX is yet \$25 million per year. This expenditure generates:
 - \$7.2 million labor income
 - 96 jobs across various including agriculture.

Table 1: Seed Industry Direct Economic Contributions to Hawaii¹³

Items	Amounts
<u>Total Annual Expenditures</u>	<u>\$264,430,000</u>
Annual Operating Expenses	\$239,375,000
Expected CAPEX	\$25,055,000
<u>Capital Expenditure Budget</u>	
Last 10-years	\$423,170,517
Next 10-years	\$250,550,000
<u>Total Labor Income</u>	<u>\$76,439,636</u>
from Annual Operating Expenses	\$69,244,274
from Annual CAPEX	\$7,195,362
<u>Total Jobs</u>	<u>1,493</u>
Employment from Operating Expense	1,397
Direct Jobs from CAPEX	96

Indirect and Induced Impacts

Besides the direct impact, the Hawaii seed industry (direct) operating and capital expenditures create ripple (i.e. multiplier) effects in the economy by generating revenues, jobs, salaries and taxes in the form of indirect and induced impacts. In order to grow their crops and perform research and development, the seed industry stimulates economic activity in other sectors of the economy (e.g. contract research organizations, input suppliers, equipment suppliers, utilities etc.) when purchases are made from these other sectors. The revenues accruing to businesses in these "support" sectors are referred to as indirect impacts of seed industry direct expenditures.

An induced impact of the Hawaii seed industry is created when workers and owners of these (indirect) companies purchase goods and services in the Hawaii economy through wages, salaries and other forms of income derived from their "support" of seed industry firms. The economic ripples (i.e. multiplier effects) generated through these expenditures

¹³ Note: The "Labor Income Portion" is a categorization of annual operating expenses to highlight this particular expenditure given its significance to policy-makers. Data are for the most recent fiscal year.

are the induced impacts. Table 2 shows the total estimated (indirect + induced) multiplier impacts of current seed industry direct expenditures in Hawaii.¹⁴

Table 2: Multiplier (Indirect + Induced) Impacts of Current Seed Industry Direct Expenditures in Hawaii

Items	Annual Operating	Average/year CAPEX	Total
Total Output (Sales)	\$262,465,793	\$24,045,725	\$286,511,518
Labor Income	\$181,728,573	\$4,776,554	\$186,505,127
Employment	924	110	1,034

Total Economic Impact of the Hawaii Seed Industry

Table 4 shows the total economic impact (i.e. direct + indirect + induced) impacts of the Hawaii seed industry to the State economy.

Table 3: Total Direct and Indirect Economic Impact of the Hawaii Seed Industry

Items	Direct Contributions	Indirect/Induced Impacts	TOTAL
<u>Total Output (Sales)</u>	<u>\$264,430,000</u>	<u>\$286,511,518</u>	<u>\$550,941,518</u>
Annual Operating Expenses	\$239,375,000	\$262,465,793	\$501,840,793
from CAPEX	\$25,055,000	\$24,045,725	\$49,100,725
<u>Total Labor Income</u>	<u>\$76,439,636</u>	<u>\$186,505,127</u>	<u>\$262,944,763</u>
from Operating Expenses	\$69,244,274	\$181,728,573	\$250,972,847
from CAPEX	\$7,195,362	\$4,776,554	\$11,971,916
<u>Total Employment</u>	<u>1,493</u>	<u>1,034</u>	<u>2,527</u>
from Operating Expenses	1,397	924	2,321
from CAPEX	96	110	206

Table 3 shows the following.

¹⁴ The 2007 Hawaii State Input-Output model is used to estimate the indirect and induced multiplier effects reported.

- The total output from annual expenses attributable to the Hawaii seed crop industry equals \$551.0 million. This amount measures the total dollar value of seed industry transactions that occur within the State related to their business. While the industry's total output comprises an insignificant less than 1% of total statewide output, the annual operating portion of the seed industry's output comprises almost 30.9% of the agriculture sector total output.
- Seed crop industry activities result in the generation of total labor income equal to \$262.9 million, which is 28.1% of total Hawaii agriculture sector labor income generated.
- Total Hawaii employment attributable to expenditures of the seed industry is approximately 2,527 jobs. This job number equates to 21.6% of all jobs (direct + indirect + induced) generated by Hawaii's agricultural sector.
- On a neighbor island sub-regional basis, seed company expenditures and jobs as a percentage of local totals would have a much larger economic impact than occurs relative to any comparison made herein. This is even more significant when discussing the agricultural sector, which generally comprises a much larger percentage of total economic activity and employment in Hawaii rural areas.

It merits noting that our measures of the economic contribution of the seed industry make no accounting of the dynamics of its knowledge creation. Such knowledge creation leads directly to increased research and development and synergistic interactions within the life sciences industry. This increases local research and development and related economic activities. For example, two new patents were issued to CTAHR in 2011. (The US Patent Office shows 101 new patents being issued overall in the State of Hawaii during the same year). These positive externalities of the seed industry are not measured in our study.

Tax Revenue Contributions

Total estimated taxes generated by Hawaii seed industry activities within the State are presented in Table 4. Table 4 shows the estimated tax amount by industry activity type and tax source. In total on an annual basis, we estimate that Hawaii seed industry activities currently generate \$29.4 million in tax revenues to the State per year. This is more than double the tax revenue amount attributable to the seed crop industry we measured in 2009.

Table 4: Fiscal Impact of the Hawaii Seed Industry

Tax	Annual		TOTAL
	Operating	CAPEX	
GET	\$12,645,889	\$1,159,080	\$13,804,970
Income Taxes	\$8,152,563	\$747,237	\$8,899,800
<u>All Other</u>	<u>\$6,107,695</u>	<u>\$559,811</u>	<u>\$6,667,507</u>
TOTAL	\$26,906,147	\$2,466,128	\$29,372,276

V. Seed Crop Industry Contribution to Achieving Public Policy Goals

What one derives from the jobs distribution information is the significant contribution the seed crop industry makes to generally stated Hawaii public policy objectives¹⁵ by its mere existence. These include the following:

- Economic diversification not only statewide but in particular on the neighbor islands where economic diversification is less than on Oahu;
- Creating jobs in a green industry, agriculture;
- Maintaining prime agricultural lands in agricultural use with little if any incentive to convert these lands to alternative use because of the industry's significant productive, profitable use of these lands in agriculture;
- Creating high-tech jobs.

It merits re-acknowledgement that the seed crop industry makes a significant contribution to achieving the public policy goals at no cost to the State. Rather this contribution is a natural response by market participants to put to productive use Hawaii's natural resources that otherwise could be idle, thereby making no economic, public policy or other contribution to the State.

Economic Diversification

A little more than 20 years ago Hawaii's agricultural sector contributed 2% of Hawaii's GSP. This percentage as in our previous studies remains less than 1%. Whether this trend reverses, abates or continues remains to be seen. The Hawaii seed industry has mitigated the downward trend of agriculture as a contributor to Hawaii economic activity maintaining this source of statewide as well as per county economic diversification.

While the seed crop industry continues to grow, it is at a much more tepid pace recently than historically. This tepid pace coincides with slowing economic conditions, which if they improve the seed crop industry may re-commence a growth rate more akin to historically. Such an eventuality would increase Hawaii's agricultural sector's contribution to economic diversification, most acutely on the neighbor islands.

¹⁵ See http://hawaii2050.org/images/uploads/HRS226_StatePlanningAct.pdf for details about Hawaii public policy goals and objectives.

Minimally, one would expect some continued growth with continued increasing food demand and the Hawaii seed crops industry contribution to meet this demand.

Aside from these general economic diversification consideration, the seed crop industry's contribution to Hawaii's agricultural sector merits highlighting.

Table 4: Seed Crop Significance to Hawaii's Agricultural Sector

Agricultural Sector	2011 Value	Seed Crop % of Sector	Sector Size Without Seed Crops
Seed Crops	\$242,970,000		0.0%
Diversified Agriculture	\$541,052,000	44.9%	\$298,082,000
All Farms	\$719,474,000	33.8%	\$476,504,000

- Without the seed crop industry the Hawaii's diversified agricultural sector would decrease by 45%.
- Without the seed crop industry the Hawaii's farm sector would decrease by more than one third.
- Neighbor island decreases in the diversified agricultural sector and overall for all farms would be much more significant than statewide averages.

In sum, without the seed crop industry, Hawaii would not only lose the single largest contributor to the sector, but diversified and overall agricultural sectors would be significantly diminished. Additionally, the land resources used by the industry could have no alternative use and thereby remain idle, unproductive and make no economic contribution to Hawaii's economy, much more significantly agriculture and statewide and sub-regional economic diversification.

VI. Conclusion

The unequivocal conclusion of this study is that the Hawaii seed industry makes significant economic and fiscal contributions to Hawaii's economy as the largest agricultural commodity and the largest diversified agricultural crop produced in the state. The industry's contribution has increased somewhat dramatically since our 2006 and 2009 industry studies. Currently, the seed industry makes direct local expenditures of \$239.4 million per year for research and development, contracts with local research organizations and local purchases of infrastructure, input supplies, and farm equipment exceed the 2006 and 2009 levels by 305% and 64%, respectively. These direct expenditures added to indirect and induced impact lead to \$550.9 million of economic activity. This activity generates \$262.9 million in annual labor income and 2,527 jobs. To place this finding in historical context, the current local seed industry's value contribution to the state currently exceeds that of sugar and pineapple combined by 66%.

The potential for the Hawaii seed industry's renewed growth after several recent years of lack luster growth remains significant in the context of growing worldwide demand for food and consequently Hawaii grown seeds to meet this demand. In response to this demand, the seed crop companies operating in Hawaii have not only been increasing their operating expense levels, but continuing capital expenditure. Continued industry investment in Hawaii bodes well for continued growth and economic contributions to the State.

Hawaii's seed crop industry is currently Hawaii's primary mode of participation in the growth of the life sciences biotechnology industry—the engine powering expected world economic growth for the next several decades. It would seem reasonable to forecast that Hawaii's life sciences biotechnology industry could become the fastest growing economic sector and one of the largest sectors of the state's economy leading to the newest biotechnology cluster in the nation, if not the world.

All possibilities together with what is actually occurring suggest that the seed crop industry has potential to play an ever more important role in the state's economy. Its growth will also advance Hawaii's technology sector through the development of an increasingly sophisticated technology-based infrastructure, scientific manpower and trained workforce.

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