Early Generation Seed System Case Study
Michigan Dry Beans

February, 2018
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**Michigan Dry Bean Case Study**

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**Appendix**
Acronyms

**MBC** | Michigan Bean Commission

**MCIA** | Michigan Crop Improvement Association

**MI** | The State of Michigan

**MSU** | Michigan State University

**MSUT** | Michigan State University Technologies
Michigan State University Breeding Program Enables the System

**VARIETAL DEVELOPMENT & SEED DEPLOYMENT**

**Varietal Development**
The Michigan State University Dry Bean Breeding and Genetics Program develops high-yielding, disease and stress resistant cultivars with upright architecture and improved canning quality in 10 commercial seed classes for production in Michigan.

**Seed Multiplication**
The Michigan Crop Improvement Association (MCIA), contracts Gen-Tech Seed Company to produce pre-breeder seed. MCIA then contracts out foundation seed production to private seed companies that produce and return or purchase foundation seed for their use in certified seed production.

**Certified Seed Production**
Certified seed production is completed by seed companies who purchase foundation seed from MCIA. MCIA acts as both the seed certifying and royalty collection agency for the seed system. MCIA collects a royalty from certified seed growers based on the amount of foundation seed purchased on a cwt basis.

**FA RMER PRODUCTION, MARKETING, AND KEY DEMAND SEGMENTS**

**Farm Production**
Commercial farms plant certified seed purchased from seed companies to produce commercial beans. Certified seed planted by commercial growers is commonly protected by Plant Variety Protection Laws, which prevent the transfer and sale of non-certified seed. An estimated 4 million cwt of commercial beans are produced from MSU varieties annually.

**Industry Advocacy**
The Michigan Bean Commission is made up of more than 1,100 bean producers and related agri-business associates. The Michigan Crop Improvement Association assists the Michigan seed industry by taking on the commercially unattractive roles of seed certification and foundation seed production. The Michigan Bean Shippers Association advocates for the industry’s downstream actors.

**Demand Segments**
The main MI bean classes (navy and black beans), are highly sought after internationally. International and domestic consumers consider dry beans from Michigan to be of higher quality than beans from other production regions. An estimated 85%* of MI navy beans are canned, while most of the MI black beans go to the Mexican packaged market.

**ENABLING ENVIRONMENT & STAKEHOLDERS**

- Michigan Crop Improvement Association
- Michigan Bean Commission
- Michigan Bean Shippers Association
- USDA

*SOURCE: Context Interviews with MSU researchers and MCIA members
Public Sector Funds Varietal Development and Contracts Private Sector to Produce EGS

**Seed System Structure**

- **Germlasm/Varieties**
- **Breeder Seed**
- **Foundation/Basic Seed**
- **Certified Seed/QDS**
- **Distribution**
- **Primary Production**
- **Distribution/Consumers**

**Who does?**
- **Public**
- **Private**

**How financially self-sustaining?**
- Low: ≤ 1/3 of OpEx
- Medium: 2/3 x > 1/3 of OpEx
- High: ≥ 2/3 of OpEx

- **BREEDER SEED**
- **FOUNDATION SEED**
- **CERTIFIED SEED**

- **CULTIVATION**
- **STORAGE**
- **CONSUMPTION**

- **Michigan Crop Improvement Association licenses new varieties from MSU and contracts private seed companies produce breeder and foundation seed**

**Varietal Development**

**Demand forecasting and production planning**
Summary of Key Success Factors

**Financial Sustainability**
- Professional Certified Seed Production
- Willingness to Pay for Quality Seed
- Structured Funding Sources
- Effective Licensing & Allocation of Royalties
- Reliable Variety Release Encourages Private Investment

**Demand Planning & Operations**
- MCIA Effectively Manages Early Generation Seed
- Certified Seed Demand is Easier to Predict Because its Value is Universally Appreciated
- Demand for Improved Varieties is Supported by the Breeding Program’s Strong Reputation
- Effective Communication of Seed Supply
- Seed Supply Risk is Mitigated Through Education & Safety Stock Buffers

**Enabling Environment**
- Respected Public Breeding Program
- Strong Alignment of Stakeholder Objectives
- Close Proximity & Collaboration Among Stakeholders
- Foundation Seed Production by a Financially Sustainable Nonprofit
- Formalized Technology Transfer Through Licensing
- Quality Control Measures Command Market Premiums

Grower commitment to seed purchase drives stability, efficiency, & cost recovery.

Several functions are performed by one not-for-profit organization, MCIA.

Concentrated group of growers supported by a publicly funded breeding program.
# Financial Sustainability

<table>
<thead>
<tr>
<th>Key Success Factors</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Professional Certified Seed Production</strong></td>
<td>A small group of private seed companies (~3) that produce and sell certified seed are highly regarded by Michigan commercial bean growers. The relationship between private seed companies and their clients (commercial growers), is personal and trust-based. It is grounded in repeated, successful negotiations for the purchase and timely delivery of clean, true-to-type certified seed of demanded quantities and varieties.</td>
</tr>
<tr>
<td><strong>Willingness to Pay for Quality Seed</strong></td>
<td>Growers of certified, MSU varieties have profited from the relative yield increases and agronomic benefits, such as increased disease resistance, drought tolerance, and disease-free lab verified seed availability, compared to un-certified seed. Their appreciation for the value proposition of quality seed (risk adjusted return of planting certified seed exceeds the incremental cost of purchasing certified seed), has contributed to farmers’ near 100% adoption of certified seed.</td>
</tr>
<tr>
<td><strong>Structured Funding Sources</strong></td>
<td>The funding mechanisms that support the seed system are well defined, and provide a steady and predictable stream of cash flows for key value chain activities including research, breeder stock management, foundation seed production, certified seed production, commercial production, and commodity marketing. The predictability of funding gained from operations (as distinct from intermittent grant funding), allows actors to be more strategic and enables long-term planning efforts.</td>
</tr>
<tr>
<td><strong>Effective Licensing &amp; Allocation of Royalties</strong></td>
<td>MSUT has streamlined its licensing process by granting MCIA the first right of refusal on new varietal releases, charging a nominal annual licensing fee per variety ($0-1,000), and establishing a fixed royalty schedule by dry bean seed class (royalty charge ranges from $40-$65 per cwt, with smaller sized beans, like black beans, carrying higher royalties). Royalties are paid on the volume of foundation seed that licensees sell to certified seed growers, not the revenue or volume of certified seed sales. The benefit of charging royalties earlier (e.g., at foundation seed sale), is increased transparency and lower accounts receivable. Licensees (MCIA), are responsible for collecting and remitting royalty payments to MSUT. The royalty amount is apportioned in one-third increments to the breeder of the variety, MSU’s Department of Plant, Soil and Microbial Sciences, and the MSU Foundation.</td>
</tr>
<tr>
<td><strong>Reliable Variety Release Encourages Private Investment</strong></td>
<td>The strong reputation of the MSU breeding program, combined with the high level of communication and coordination between value chain actors encourages investment in varietal adoption and promotes accurate demand planning between foundation seed producers, certified seed growers, and commercial growers.</td>
</tr>
</tbody>
</table>
## Demand Planning and Operations

MCIA serves as the key link between MSU’s Dry Bean Breeding and Genetics Program, and the private sector. It licenses nearly all of MSU’s newly released varieties, and is responsible for foundation seed demand planning, production, and order fulfillment. It is also the seed certification authority in Michigan. MCIA’s ability to effectively manage demand planning through constant communication with growers and the industry has enabled its status as a financially self-sustaining nonprofit. MCIA adds value to the industry by assuming exposure to the risk of errant demand projections by certified seed companies. In the absence of MCIA, the public and private sector would have to assume the commercially unattractive functions of dry bean early generation seed multiplication and certification.

### Certified Seed Demand is Easier to Predict Because its Value is Universally Appreciated

Commercial farmers value certified seed and are the driving force behind a certified bean seed system that features near 100% adoption and annual replacement of certified seed. Growers’ valuation of certified seed has been informed by varietal field demonstrations and communication of varieties’ features, attributes, and benefits by Michigan State University, Michigan Crop Improvement Association, Michigan Bean Council, and the Michigan Bean Shippers.

### Demand for Improved Varieties is Supported by the Breeding Program’s Strong Reputation

MSU Dry Bean Breeding and Genetics program’s robust germplasm bank, breeding expertise, and close collaboration with other regional bean breeding programs has contributed to its strong varietal pipeline. The Program’s penchant for releasing new, improved varieties keeps growers interested in “what’s next.” Growers are informed about promising pre-release varieties through formal and informal channels (e.g., monthly, regional Michigan Bean Commission meetings and the annual Dry Bean Outlook Conference).

### Effective Communication of Seed Supply

Seed companies are in daily communication with their customers (commercial growers), and are vertically integrated commodity trading companies to anticipate certified seed demand. Dry bean certified seed dealers meet annually to share information on the anticipated supply of dry beans, by variety, for the coming year.

### Seed Supply Risk is Mitigated Through Education & Safety Stock Buffers

MSU Extension, MCIA, and industry-led outreach efforts aim to mitigate seed companies’ exposure to seed quality losses, which come in many forms, including: seed producer issues, mixtures in processing, weather issues, seed borne disease, and genetic drift. MCIA and certified seed producers further manage their operational risk by building in a ~10% safety stock buffer to hedge against seed quality and seed supply issues.
Enabling Environment

**Respected Public Breeding Program**
Farmer and seed industry trusted breeding program that features a robust germplasm bank and is led by an accomplished breeder, who has a history of consistently releasing improved varieties that increase grower incomes via increased yields, disease resistance, and optimized plant structure that improves the efficiency of bean crop cultivation (i.e. erect plant structure that enables direct mechanical harvest).

**Strong Alignment of Stakeholder Objectives**
Stakeholder incentives are aligned to support the expansion and profitability of Michigan dry bean production. Unlike in U.S. maize and soybean production, the profit pool in the Michigan bean industry is insufficient to support vertically integrated commercial seed companies that participate along the seed value chain – from varietal development to seed sales. As a result, there is a necessary interdependency among stakeholders (breeders, MCIA, certified seed growers, and farmers), who rely on one another to support the efficient deployment of released, public sector varieties to Michigan growers.

**Close Proximity & Collaboration Among Stakeholders**
Michigan bean production is geographically focused, with a majority of production occurring within six contiguous counties in East Central Michigan. The close proximity of actors, including breeders, growers, seed certifiers, extension officers, and buyers, encourages the development of trust-based relationships, and an intense focus on addressing the prioritized issues of a largely homogeneous and agro-ecological environment.

**Foundation Seed Production by a Financially Sustainable Nonprofit**
The Michigan Crop Improvement Association provides a critical link between varietal release and seed deployment to farmers. It manages the production and delivery of foundation seed to certified seed growers on a financially sustainable, but not-for-profit basis. Its assumption of this necessary, but non-commercial value chain step, enables private sector seed companies to focus on certified seed production where the business case is stronger due to lower unit production costs and higher seed volumes.

**Formalized Technology Transfer Through Licensing**
MSU’s Office of Technology streamlines the release of new varieties by executing standardized varietal licenses with the Michigan Crop Improvement Association, which has the first right of refusal on the first variety of each dry bean class that is released annually by MSU’s Bean Breeding & Genetics Program.

**Quality Control Measures Command Market Premiums**
Production quality has been a differentiating characteristic of Michigan black beans, and is the reason why they command a price premium in key export markets (e.g. Mexico). Grower assurance that the certified seed that they purchase and plant is true-to-type, and disease free, is supported by MCIA’s strict seed certification process, which is unreserved in rejecting fields that do not meet Michigan’s seed certification requirements. This is evidenced by its ~30% rejection rate of fields that it evaluates for certification.
# EGS Seed System Pain Points

## Financial Sustainability

**Risk of Underperforming Varieties:** All parties in the seed system face risk when investing in new bean varieties. Underperforming varieties have had significant time, labor, and capital investments made by the time they reach the commercial market. If varieties fail, MCIA, growers, and seed companies all bear the costs.

**Farmer Ability to Switch Crops:** Michigan commercial farmers have the ability to switch away from dry beans to other crops (e.g., corn, soy), threatening the seed system’s overall stability. Growers must be incentivized through high-performance varieties and a healthy dry bean market to continue to produce dry beans over other crops.

**Lack of Operational Funding:** MSU’s Breeding and Genetics Program lacks earmarked funding for necessary operational roles (e.g., field and lab technician salaries and graduate student stipends), which causes funding to be allocated from project-specific budgets. The practice of resourcing these positions is routine and necessary, but consumes a large number of high-value labor hours.

## Demand Planning & Operations

**Consumer Preference Shifts:** Dry bean varieties are susceptible to changes in consumer preferences, which have corresponding demand implications. For example, navy beans are a focus variety for MSU, however demand from consumers has waned due to their use in baked beans, which has a higher relative sugar content to other types of bean products. This required the system to respond by reallocating resources to classes with increased demand.

**Supply Variance:** Seed companies contract the production of certified seed to specialized growers. The number of specialized growers fluctuates from season to season based on market conditions and their opportunity cost (what is the highest return on the acre?).

**Demand Variance:** Demand for certified seed, which is forecasted at least one year before it is ordered, fluctuates with the number of commercial growers each year. The timing of production decisions, and the variability of producer demand, makes accurate demand planning a challenge for MCIA and for certified seed companies.

**Seed Quality Failures:** Failures in seed quality affect all operations of the seed system and result in rejected fields and an interrupted supply. Failures can come in many forms including seed grower error, mixtures in processing, weather issues, seed borne diseases, and genetic drift effects. Michigan’s global reputation as a premium source of dry beans is supported by growers’ adherence to seed certification guidelines, which leads to higher prices at the expense of certified field rejections.

## Enabling Environment

**Public Good:** The success of MSU’s Dry Bean Breeding and Genetics Program in delivering new, improved varieties to the market has created a reluctance on the part of industry to increase its investment in research and development for a perceived public good. The rationale being, if the system is working, then there is no need to increase funding. As a result, industry funding in support of the Breeding Program has remained relatively flat, while its operational costs have increased with inflation, and prospective capital investments in infrastructure upgrades and advanced breeding technologies have gone un-resourced. This dynamic has caused the Breeding Program to perform the same operational activities with a smaller effective budget.

**University IP Policy Constrains MSU’s Germplasm Bank Potential:** MSU operates under a policy that limits the Breeding Program’s ability to transfer and accept germplasm from third party institutions that could strengthen its germplasm bank.
Michigan Dry Bean EGS System

<table>
<thead>
<tr>
<th>1900-1959</th>
<th>1960-1999</th>
<th>2000-Present</th>
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<tbody>
<tr>
<td>1862- MSU became a NIFA-Funded Land Grant University</td>
<td>1964- MI Bean Commission, est. by the MI state legislature, began collecting voluntary assessments from growers to fund breeding, research &amp; promotion</td>
<td>2014- MCIA raised foundation seed prices from $120/cwt to $125/cwt</td>
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<tr>
<td></td>
<td>1990- MSU created the MSU Tech IP office and initiated royalty fee collections on dry bean varieties, ending the voluntary grower assessment. The result was that the breeding program now only receives 1/3 of these royalties, decreasing its overall funding</td>
<td>2018- MCIA raised foundation seed prices another 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Continued review of check off fund collection every five years</td>
</tr>
<tr>
<td>1900s- Est. of bean breeding program at MI Agricultural Experiment Station, MI State College (later becomes MSU)</td>
<td>1980- Dr. Jim Kelly joined MSU Dry Bean Breeding &amp; Genetics Program</td>
<td>2014- MCIA installed Buhler/Sortex Color Sorter into foundation seed production warehouse to increase seed output quality. Result was increased demand from members and need for increased warehouse space in 2015</td>
</tr>
<tr>
<td>1915- Dr. Spragg released MI’s first navy bean variety from the MI Agricultural Experiment Station- beginning of dry bean breeding program</td>
<td></td>
<td>2015- MCIA provided interested growers with printable seed tags, allowing growers to print their own tags and save on delivery time and postage costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2016- MCIA Seed Lab began accepting credit card payments for services. Foundation seed still required to be paid by check</td>
</tr>
<tr>
<td>1927- Michigan Crop Improvement Association incorp. as a nonprofit by Michigan seed growers for seed certification, quality assurance, identity preserved program, foundation seed production, conditioning, seed quality testing, and phytosanitary disease inspections</td>
<td>1965- Michigan Seed law Act enacted to regulate sale of seed, provide for seed inspections and testing, prohibiting certain activities related to seed, and prescribing penalties for violation</td>
<td>2014- MI selected for pilot insurance program by the USDA Risk Management Agency, helping level risks in dry beans with the same assurances growers receive in soybeans and corn</td>
</tr>
<tr>
<td></td>
<td>1980s- MI Bean Commission and Bean Shippers developed disaster relief initiative for MI growers suffering from flooding loss and signed contracts with Mexican government, launching the state’s colored bean business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1996- Field beans provision made to MI Seed Law that requires all dry bean seed produced in MI to be field inspected and lab tested</td>
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Michigan Crop Improvement Association is the key (and critical) factor in tying the main actors of Michigan dry bean industry together:

- **MCIA was established at the request of growers in 1927 and continues to provide them with value and improvements in operations and quality. The Association is open to taking suggestions on improving how growers receive services (credit card payments for seed lab uses) and responds to meet increases in grower demand (new warehouse in 2015). The ability of MCIA to provide several services to growers while also being willing to listen to their needs and evolving to meet those needs is a key success factor in the evolution of the dry bean industry.**

Prior to 1990, the MI Bean Commission instituted a voluntary assessment on all seed produced and acres grown from MSU varieties. That assessment went straight back to MSU to fund commodity research and the breeding programs in the respective crops. In 1990, MSU created an IP office (MSU Technologies) and initiated fee/royalty collection on all intellectual property (including dry bean varieties), effectively ending the voluntary assessment collection. As a result of this change, now, only 1/3 of royalties collected on seed produced go back to the breeder and/or breeding program at the discretion of the breeder/inventor. In Dr. Kelly's view, this change negatively impacted the breeding programs by putting them at a disadvantage as the costs to conduct research increase.
Market Dynamics
U.S. is a Premium Producer of Several Dry Bean Classes

The U.S. Ranked 4th for Total Production of Dry Beans in 2016*

<table>
<thead>
<tr>
<th>#Country</th>
<th>2016 Production Total (tons)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Myanmar</td>
<td>5,708,975</td>
<td>19%</td>
</tr>
<tr>
<td>2 India</td>
<td>4,287,372</td>
<td>15%</td>
</tr>
<tr>
<td>3 Brazil</td>
<td>2,877,415</td>
<td>10%</td>
</tr>
<tr>
<td>4 United States of America</td>
<td>1,396,908</td>
<td>5%</td>
</tr>
<tr>
<td>5 United Republic of Tanzania</td>
<td>1,273,843</td>
<td>4%</td>
</tr>
<tr>
<td>6 China (incl. Taiwan)</td>
<td>1,253,853</td>
<td>4%</td>
</tr>
<tr>
<td>7 Mexico</td>
<td>1,197,644</td>
<td>4%</td>
</tr>
<tr>
<td>8 Uganda</td>
<td>1,109,251</td>
<td>4%</td>
</tr>
<tr>
<td>9 Kenya</td>
<td>800,976</td>
<td>3%</td>
</tr>
<tr>
<td>10 Ethiopia</td>
<td>532,315</td>
<td>2%</td>
</tr>
<tr>
<td>11 Rwanda</td>
<td>481,440</td>
<td>2%</td>
</tr>
<tr>
<td>12 All Others</td>
<td>8,596,741</td>
<td>29%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29,516,733</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: FAOSTAT

30% INCREASE in acres harvested for dry beans may be attributed to low prices in commodity crops

30% INCREASE in acres harvested for dry beans may be attributed to low prices in commodity crops

West and Northern Plains states experienced drought in 2017 that lead to YIELD DECLINES to levels not seen since 1944

PINTO, NAVY, and BLACK BEANS accounted for 78% of area planted in 2017

Source: USDA ERS

* 2016 production rankings reflect volumes for all bean classes grown in the respective countries. When considering the rankings of bean production relative to classes grown in Michigan, Brazil is the clear leading producer in recent years.
More Than 80% of MI Dry Bean Production is Concentrated in Six Counties

**Close Proximity of Researcher and Producers.** East Lansing is Michigan’s state capital and is home to Michigan State University, the MSU Dry Beans Breeding and Genetics Program, MSU Extension, and Michigan Crop Improvement Association. It is located in close proximity to the primary production counties of the state (within a hundred miles).

**Michigan Beans Are a Premium Brand.** Michigan Dry Beans command a price premium in the global market due to their consistent, high-quality production, and their preferred cooking characteristics (e.g. the higher relative moisture of MI black beans reduces their cooking time).
Michigan is the **SECOND HIGHEST** producer of dry beans in the U.S.

Michigan was a leader in producing white beans for several years, but **DIVERSIFICATION** was needed for exports

Now, **12 DIFFERENT CLASSES** of dry beans are grown in the state

**MSU EXPANDED BREEDING** to several different classes to alter growth habit, local adaptations, and different levels of disease resistance

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**Michigan Dry Bean Classes**

- Light Red Kidney
- Dark Red Kidney
- Small Red
- Navy
- Great Northern
- White Kidney
- Pink
- Pinto
- Cranberry
- Scarlet
- Black
- Yellow Eye

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**In 2016, black beans represented the greatest production of dry beans, followed by navy beans**

- **Black Beans**: 202.9 cwt
- **Navy Beans**: 130.6 cwt
- **Small Red Beans**: 34.8 cwt
- **Cranberry Beans**: 4.1 cwt
- **Dark Red Kidney Beans**: 3 cwt

*No data available for Pinto Beans*

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SOURCE: Dr. Jim Kelly various presentations
Michigan Dry Bean Production Trends

**Takeaways From 2011-2015 Harvested Acres**

- Dry Bean Production Acres Increased by 10.1%
- Black Bean and Navy Bean Were CAGR Growth Leaders at 12% and 10%, Respectively
- The Small, Red, Cranberry, and Red Kidney, Dark Classes Grew at +5% CAGR From 2011 and 2015

**Harvested Acres of Dry Bean Varieties in Michigan**

- Black: 2011: 79,000, 2015: 139,000
- Small, Red: 2011: 18,000, 2015: 27,300
Dry Bean Demand Drivers by Stakeholder

**For Growers:**
- High yielding and low cost of production
- Disease resistance (root rot, white mold, anthracnose) and drought tolerance
- Fast maturing

**For Canners:**
- Beans must be able to withstand the canning process
- Varieties must possess consumer-demanded traits (e.g., color retention and uniformity)

**For Consumers:**
- Consumer preference for healthful foods
- Increased popularity of gluten-free diets
- Willingness to pay for organic production
- Specific varietal preferences
## Organizational Value Chain Leadership Summary

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<tr>
<th>ORGANIZATION</th>
<th>ROLE</th>
<th>VALUE CHAIN ROLE</th>
<th>FUNDING SOURCES</th>
<th>FINANCIAL SUSTAINABILITY</th>
</tr>
</thead>
</table>
| A | Michigan State University Dry Bean Breeding and Genetics Program | • Varietal development  
• Basic genetic research  
• Student training  
• Industry outreach about new varieties | • Federal and state funding via university allocation  
• Federal grants (USAID, NIFA)  
• Special projects (Dept. of Agriculture, MBC)  
• Partial royalties on licensed MSU varieties  
• Partial allocation of check off funds; majority of check off funds allocated for industry agronomist salary from the Michigan Bean Commission | PUBLIC SECTOR SUBSIDIZED |
| B | MSU Technologies (MSUT) | • Facilitates the commercial development and public use of MSU-developed varieties | • University funding through MSU’s Vice President for Research and Graduate Studies Office and the MSU Foundation | FINANCIALLY SUSTAINABLE |
| C | Michigan Crop Improvement Association | • Licensee of new varieties  
• Foundation seed order management, contract producer, and supplier  
• Royalty collection  
• Seed certification | • Revenue from foundation seed sales  
• Seed company association dues  
• Seed certification charges  
• NOTE: MCIA remits all collected royalties to MSU Technologies | FINANCIALLY SUSTAINABLE |
| D | Michigan Bean Commission | • Advocate for the interests of Michigan dry bean producers | • Assessment on dry bean producers based on their production acreage (more commonly known as a ‘commodity checkoff program’) | FINANCIALLY SUSTAINABLE |
| E | Michigan Bean Shippers | • Advocate for the interests of Michigan bean shippers, processors, and marketers | • Membership dues and corporate sponsorships through the Michigan Agri-Business Association | FINANCIALLY SUSTAINABLE |
Organizational Leadership by Value-Chain Step

Board Representation: Farmers | Breeders | Certified Seed Producers | Extension | Industry | USDA

Breeder
Foundation
Certified
Commercial
Buyers

MSU
MCIA
Independent Seed Companies & Integrated Commodity Trading Companies
MI Growers
Commodity Trading Companies & Canners

Licensing (MSU Technologies)
Royalty Collection (MCIA)
Seed Certification (MCIA)
Check-Off Fund Collection (MBC)
MSU Dry Bean Breeding and Genetics Program

**OBJECTIVE:** “To Develop Improved Dry Bean Varieties in Several Commercial Classes to Serve the Bean Growers, Bean Seed Producers, and Bean Industry of Michigan” Breeding Program

**KEY RESPONSIBILITIES:**

- **New Variety Development:** The breeding program focuses on developing varieties that are high-yielding, stress and disease resistant, have upright architecture, and improved canning qualities in 10 classes of dry beans.

- **Industry Outreach:** The breeding program disseminates new research information to growers, crop advisors, and other industry professionals at industry events and conferences. Information sharing often centers on research developments about disease resistance & pest management and new variety progress.

**FUNDING**

Breeding program activities are funded by: Federal and state funding allocated by MSU, state- and federally-funded grants, special projects sponsored by MBC, and royalties collected on released varieties.

- Dr. Jim Kelly, Head Breeder
  - Dr. Kelly leads the MSU Dry Bean Breeding and Genetics Program. He joined MSU faculty in 1980, has developed over 49 bean varieties, and is well respected within the U.S. dry bean industry.

- Dr. Kelly’s Bean Laboratory Team
  - The MSU Dry Bean Breeding and Genetics Program currently employs 35 Master and PhD level researchers focused on dry bean breeding and research.
MSU Technologies (MSUT) – Licensing of Released Varieties

**OBJECTIVE:** To facilitate the commercial development and public use of technologies and copyrightable materials developed by MSU faculty and staff.

**KEY RESPONSIBILITIES:**

- **Varietal Licensing & Technology Transfer:** MSUT is responsible for licensing released MSU dry bean varieties.

- **Negotiate Royalty Amounts:** MSUT negotiates royalty amounts with MCIA once a new variety is approved for release. The royalty amount varies by bean class to account for the difference in seed size and seed weight by class.

- **Royalty Allocation:** MSUT receives and allocates royalties from the sale of foundation seed.

**FUNDING:**

MSUT’s operational budget is funded by MSU’S Vice President for Research & Graduate Studies Office and by the MSU Foundation.

**LICENSING PROCESS:**

- **Screening & Assessment:** Varieties are subjected to a three committee review, which include representation from:
  - MCIA
  - MI Department of Agriculture
  - MCIA Crop Specialists
  - MSU AgBioResearch Representatives

- **Marketing:** MSUT provides assistance in identifying potential licensees for new varieties. MCIA has the first right of refusal for all MSU varieties, so very few MSU varieties are made available for licensing to other entities.

- **Licensing & Compliance:** MSUT negotiates licenses and royalties with MCIA. While licensed varieties are in the market, MSUT assists in assuring all license conditions are met.
Michigan Crop Improvement Association (MCIA) – Foundation Seed Production & Seed Certification

**PURPOSE:** “To foster and promote the production and use of improved seed stocks in Michigan, to serve as an official seed certification agency for the state of Michigan and to provide other related services to benefit its members and the agricultural industry.” MCIA

**KEY RESPONSIBILITIES:**

- **Breeder Seed Bulking & Foundation Seed Production:** MCIA contracts the bulking up of breeder seed (1 company), and the production of foundation seed (~4 companies), on dry bean varieties that it licenses from MSU.

- **Foundation Seed Demand Planning and Sales:** MCIA coordinates foundation seed orders from certified seed growers.

- **Royalty Collection:** MCIA collects payments from the sales of foundation seed and remits the royalty payments to MSUT.

- **Seed Certification:** MCIA is charged as the certifying authority for MSU varieties. Thirty-five seed certifying inspectors are employed by the Association.

**LEADERSHIP:**

MCIA’s Board of Directors provides strategic direction and features broad industry representation, including senior leaders from MSU, the Michigan Bean Commission, Certified Seed Producers, USDA, and Growers.

**FUNDING:**

MCIA is a nonprofit organization that covers its operating expenses through revenues on the foundation seed it sells to certified seed growers. Revenues from foundation seed sales fully fund MCIA foundation seed production activities. MCIA remits 100% of collected royalties to MSU Technologies and does not use any royalties to fund its operations. Sales of dry bean foundation seed contribute 65% of revenues to MCIA.

**VARIETAL LICENSING:**

MCIA has the first right of refusal to license the first dry bean variety in each class released by MSU annually. It licenses the new varieties from MSU’s Technology Office for a fixed royalty that is established by the class of the dry bean. To date, all but one MSU released varieties have been licensed by MCIA.

MCIA also provides foundation seed production and seed certification services for corn, wheat, rye, oats, barley, soybeans, and peas.
Michigan Bean Commission (MBC) – Farmer Advocacy

**OBJECTIVE:** Benefit Michigan's dry bean growers by promoting research on varieties and production practices; improving bean products’ food, therapeutic and dietetic value; conducting market development and research studies; and implementing promotional programs.

**KEY RESPONSIBILITIES:**

**Facilitate Industry Connections:** Commission meetings & events connect growers, researchers, shippers, the U.S. Dry Bean Council, and MBC leaders to share industry news and MBC initiatives.

**Collect & Manage Check Off Funds:** MBC collects check off funds from commercial growers ($0.10 per hundredweight sold). $0.01 is allocated to pay the salary of the dry bean industry agronomist and $0.09 is allocated for industry marketing efforts.

**Disseminate Market Information & Cultivate Export Markets:** Promote the value proposition of Michigan dry bean production, domestically and internationally, to capture premium pricing.

**ORGANIZATIONAL STRUCTURE:**

Executive Committee
Led by Three Elected Growers

Subcommittees
Bean Shippers
Grower Insurance
Research
Growing District Representatives
National Representation

An executive committee oversees the Commission’s operations and each bean growing district is represented by a commissioner. Commission meetings are held every two months and additional events are held throughout the year (e.g. Annual Dry Bean Outlook Conference).

**FUNDING:**

MBC’s operations are funded through agricultural assessments collected on the volume of beans sold ($0.10/cwt sold) each season. The agricultural assessment amount is renegotiated every 5 years.

Source: [https://www.michfb.com/MI/News/Press_Releases/Bean_growers_renew_checkoff/](https://www.michfb.com/MI/News/Press_Releases/Bean_growers_renew_checkoff/)

http://michiganbean.org/about-us/
Michigan Bean Shippers Association

OBJECTIVE: Serve the Michigan dry bean industry by connecting Michigan bean growers and members of the elevator industry to dry bean customers around the world.

ASSOCIATION DETAILS

Member of a Larger Michigan Agricultural Association: “The Michigan Agri-Business Association comprises the heart of the industry—seed, fertilizer, and crop protection manufactures, retailers and advisers, grain handlers, feed suppliers, and food processors. All major commodity groups in Michigan are represented as well.”

The Michigan Bean Shippers Association is made up of a 6-person board: One president and five trustees oversee the operations of the Association.

Provides Funding for Breeding & Research: The Michigan Bean Shippers Association matches the research funding allocated by the Michigan Bean Commission from check off fund revenues. This money is the main funding source for employing the bean industry agronomist.

The Association provides an online directory of bean shippers and elevators in Michigan through the Michigan Agri-Business Association Website.
Research & Varietal Development
Breeding Objectives for the MSU Dry Bean Breeding Program include:

- Improve Yield & Quality
- Improve Disease Resistance
- Improve Plant Architecture
- Introduce Diversity

Breeding Tools:

- Pedigree Breeding
- Backcrossing, Marker Assisted Selection (MAS)
- Recurrent Selection
- Inbred BC
- Gene Mapping & Analysis
- QTL Analysis for Quantitative Traits, Genome Wide Association Mapping

SOURCE: MSU Dry Bean Breeding & Genetics Program
The Breeding Program Functions Within a Larger, University Enabled System

**MSU AgBioResearch** is the key to connecting all MSU entities involved in new variety development and release

“MSU AgBioResearch encompasses the work of more than 300 scientists in seven colleges at MSU: Agriculture and Natural Resources, Arts and Letters, Communication Arts and Sciences, Engineering, Natural Science, Social Science and Veterinary Medicine.

These researchers, in on-campus laboratories and at 13 outlying research centers across the state, investigate topics that range from agricultural production, alternative energy and biofuel production, food safety and environmental stewardship to childhood obesity, community development, and the quality of life of Michigan youth and families. Michigan citizens reap the benefits of this work in the form of new or improved foods and plants, new production methods and enriched lifestyles.” [MSU AgBioResearch](https://www.msu.edu/)

Effective breeding and varietal releases are possible through the **collaboration** of MSU research programs including:

- Agronomists
- Plant Pathologists
- Chemists
- Social Scientists

Source: MSU Dry Bean Breeding & Genetics Program Discussion
Breeding Program Prioritized Plant Architecture Which Allowed Mechanized Harvesting and Increased Profitability

Dry Bean breeding methods over the past 20 years have focused on developing an **IMPROVED TYPE OF BEAN STALK** that is:

- Taller
- Has a deeper taproot
- Has longer maturity
- Has greater stand strength
- Stands upright as an architectural avoidance to white mold and other diseases

These improved methods have led to the ability to **DIRECT HARVEST** beans in the US and Canada, resulting in:

- Labor, Time, Equipment Savings
- Improved Quality & Flexibility
- More Acreage Covered

SOURCE: MSU Dry Bean Breeding & Genetics Program
Stage Gate Process – Breeding to Seed Deployment

10-year breeding process for breeding new varieties:

<table>
<thead>
<tr>
<th>Breeding Phase</th>
<th>Seed Generation</th>
<th>Location of Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year 1-3</strong></td>
<td>Crossing and Early Generation Selection</td>
<td>Greenhouses, Fields in MI and Puerto Rico</td>
</tr>
<tr>
<td><strong>Year 4-6</strong></td>
<td>Yield Testing, Canning Testing</td>
<td>Generations: Replicated F6-Prerelease</td>
</tr>
<tr>
<td><strong>Year 7-9</strong></td>
<td>Seed increases (Breeder, Foundation, Certified)</td>
<td>Breeder seed through Certified seed</td>
</tr>
<tr>
<td><strong>Year 10</strong></td>
<td>Certified Seed Available to Commercial Growers</td>
<td></td>
</tr>
</tbody>
</table>

Potential New Bean Varieties
Planted in one of the Dry Bean Breeding and Genetics Program’s greenhouses on MSU’s campus. These plants are used for crossing and selection during Years 1-3 in the breeding process.

Utilizing Test Fields in Puerto Rico
Allow for extra production cycles of new bean varieties each year, decreasing the total number of years required for testing before release.

SOURCE: MSU Dry Bean Breeding & Genetics Program
Seed Multiplication Timeline

5-year process from Pre-Breeder Seed to Commercial Seed:

<table>
<thead>
<tr>
<th>Breeding Phase</th>
<th>Approx. Amount of Seed Generated</th>
<th>Description</th>
<th>Location of Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 6</td>
<td>1 lb.</td>
<td>Establishing Phase</td>
<td>MSU</td>
</tr>
<tr>
<td>Year 7</td>
<td>40 lbs.</td>
<td>Multiplication Phase</td>
<td>Fields in Western States</td>
</tr>
<tr>
<td>Year 8</td>
<td>1,600 lbs.</td>
<td>Distribution Phase</td>
<td>Michigan and other locations based on distribution company</td>
</tr>
<tr>
<td>Year 9</td>
<td>64,000 lbs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 10</td>
<td>Distribution of Commercial Seed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Most of the seed increases for Foundation and Certified Seeds occur in Western U.S., not in Michigan:

- The BREEDER SEED SOURCE is increased by contracted growers and local companies in WA and ID
- Top companies include Treasure Valley Seed, ADM, and Kelley Bean
- Drier conditions out West decrease the RISK OF SEED-BORNE DISEASE ISSUES present in Michigan
- MULTIPLICATION PROCESS takes 3 years

SOURCE: MSU Dry Bean Breeding & Genetics Program
Improved Dry Bean Varieties Begin in the MSU Breeding Greenhouses

Dr. Kelly and his breeding staff are responsible for managing the all stages of new dry bean variety development.

Greenhouses in Lansing, MI house the improved dry bean varieties currently in development.

Dr. Kelly and his team make selections and crosses based on data collected over several months.

Once crosses are made, the most promising varieties are chosen for planting and further testing.

Disease resistance is a main breeding goal for dry beans and Dr. Kelly’s team does extensive resistance testing of new varieties.

New lines and varieties are kept separate in greenhouses through the use of a hand-tagging and naming system.

Pre-breeder seed is established at MSU before being sent for multiplication in Western U.S. states.
Growers and Industry Learn More About New Varieties Through MSU Release Bulletins

New Variety Bulletins Are Made Available To The Public Through The MSU Dry Bean Breeding and Genetics Program Website, The MSU Dry Beans Extension Website, and Industry Events

Source: MSU Dry Bean Breeding and Genetics Program
Canning: A Special Case of Trait Importance

“Breeders have to ensure that the line meets the essential characteristics - yield, agronomics, and canning - that are superior to what is already in the market.” – Jim Palmer, MCIA

<table>
<thead>
<tr>
<th>THE SITUATION:</th>
<th>Beans must be <strong>PROCESSED</strong> before being consumed. This requires that beans be bred to <strong>WITHSTAND THE CANNING PROCESS</strong>.</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE BREEDING SOLUTION:</td>
<td><strong>ELIMINATE</strong> the varieties that prove to <strong>BREAK EASILY</strong> from the breeding program and only keep those varieties with other <strong>DESIRABLE CANNING TRAITS</strong>.</td>
</tr>
<tr>
<td>CANNING QUALITY TRAITS:</td>
<td>Visual Selection by trained judges</td>
</tr>
<tr>
<td></td>
<td>Whole Seed integrity</td>
</tr>
<tr>
<td></td>
<td>Color Retention and Uniformity</td>
</tr>
<tr>
<td></td>
<td>Clear Brine</td>
</tr>
<tr>
<td></td>
<td>Hydration Ratios</td>
</tr>
<tr>
<td></td>
<td>Drained Weights</td>
</tr>
<tr>
<td></td>
<td>Texture</td>
</tr>
<tr>
<td></td>
<td>Commercial Evaluation of elite lines</td>
</tr>
</tbody>
</table>

**SOURCE:** MSU Dry Bean Breeding & Genetics Program

[Image: Industry Agronomist, Greg Varner, shows Dry Beans Separated by Dry Bean Class for Canning Testing. Dr. Varner and his team portion out the sampling beans to streamline the canning testing process.]

[Image: Specialized equipment allows for testing of hydration ratios in new bean varieties. This testing enables efficient evaluation of new bean varieties.]
Demand Planning and Operations
Michigan State University Breeding Program Enables the System

**SEED SYSTEM OVERVIEW**

**Varietal Development & Seed Deployment**

**Varietal Development**
The Michigan State University Dry Bean Breeding and Genetics Program develops high yielding, disease and stress resistant cultivars with upright architecture and improved canning quality in 10 commercial seed classes for production in Michigan.

**Seed Multiplication**
The Michigan Crop Improvement Association (MCIA), contracts Gen-Tech Seed Company to produce pre-breeder seed. MCIA then contracts out foundation seed production to private seed companies that produce and return or purchase foundation seed for their use in certified seed production.

**Certified Seed Production**
Certified seed production is completed by seed companies who purchase foundation seed from MCIA. MCIA acts as both the seed certifying and royalty collection agency for the seed system. MCIA collects a royalty from certified seed growers based on the amount of foundation seed purchased on a cwt basis.

**Farmer Production, Marketing, and Key Demand Segments**

**Farm Production**
Commercial farms plant certified seed purchased from seed companies to produce commercial beans. Certified seed planted by commercial growers is commonly protected by Plant Variety Protection Laws, which prevent the transfer and sale of non-certified seed. An estimated 4 million cwt of commercial beans are produced from MSU varieties annually.

**Industry Advocacy**
The Michigan Bean Commission is made up of more than 1,100 bean producers and related agri-business associates. The Michigan Crop Improvement Association assists the Michigan seed industry by taking on the commercially unattractive roles of seed certification and foundation seed production. The Michigan Bean Shippers Association advocates for the industry’s downstream actors.

**Demand Segments**
The main MI bean classes (navy and black beans), are highly sought after internationally. International and domestic consumers consider dry beans from Michigan to be of higher quality than beans from other production regions. An estimated 85%* of MI navy beans are canned, while most of the MI black beans go to the Mexican packaged market.

**Enabling Environment & Stakeholders**

Michigan Crop Improvement Association | Michigan Bean Commission | Michigan Bean Shippers Association | USDA

*SOURCE: Context Interviews with MSU researchers and MCIA members*
# Early Generation Seed Deployment Model

<table>
<thead>
<tr>
<th>Who</th>
<th>Pre-Breeder Seed</th>
<th>Breeder Seed</th>
<th>Foundation Seed</th>
<th>Certified Seed</th>
<th>Commercialization</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSU Dry Bean Breeding and Genetics Program</td>
<td>Michigan Crop Improvement Association Foundation Seed Agency through Gen-Tech Seed Company</td>
<td>Private Seed Companies on Contract Basis for Michigan Crop Improvement Association TV Seed (Trinidad Benham), ADM, Central Bean</td>
<td>Independent Growers on Contract Basis with Certified Seed Companies Buys Foundation Seed from MCIA</td>
<td>Independent Growers Buy from Certified Seed companies</td>
<td></td>
</tr>
<tr>
<td>Sector</td>
<td>Public</td>
<td>Public</td>
<td>Public</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td>Input</td>
<td>Pre-Breeder Seed to MSU Greenhouses for multiplication</td>
<td>1 lb. Pre-Breeder Seed</td>
<td>40 lb. Breeder Seed</td>
<td>1,600 lb. Foundation Seed</td>
<td>64,000 lbs. of certified seed</td>
</tr>
<tr>
<td>Output</td>
<td>1 lb. Pre-Breeder Seed</td>
<td>40 lb. Breeder Seed</td>
<td>1,600 lb. Foundation Seed</td>
<td>64,000 lb. Certified Seed</td>
<td>2.5 million lb. of Commercial Beans</td>
</tr>
<tr>
<td>Capital Sources</td>
<td>• Federal and state funding Federal grants • Special projects funding • Partial royalties on licensed MSU varieties</td>
<td></td>
<td>Sales of foundation seed to certified seed companies</td>
<td>• Sale of certified seed • NOTE: Certified seed companies pay royalties on the volume of foundation seed they purchase from MCIA</td>
<td>• Sale of dry beans • 4 million cwt of commercial beans produced from MSU varieties annually</td>
</tr>
</tbody>
</table>
Pre-breeder seed is developed in an MSU greenhouse once it is determined that the variety will be released. The pre-breeder step can occur prior to the official variety release announcement if the breeder is confident that the three release committees will approve its release. MCIA licenses pre-breeder seed through MSUT to Gen-Tech Seed Company, which multiplies the pre-breeder seed out to 40 lbs. of breeder seed in western U.S. states. Royalty amounts are determined by market class.

Breeder seed is multiplied to ~1,600 lbs. of foundation seed by contracted seed production companies located in western U.S. states, including Idaho, Washington, and Wyoming, due to the drier climate and lower relative disease pressure in those areas as compared to Michigan. MCIA specifies the volume of foundation seed to be produced based on orders it receives one year in advance from certified seed growers and based on current seed inventories.

Certified seed is produced by certified seed companies, mostly on a contract basis from seed production companies, both within and outside of Michigan. Most royalties are paid by certified seed companies on the amount of foundation seed they purchase from MCIA for their contracted growers, with options to pay royalties on certified seed for in-state seed companies. More than 90% of commercial acreage grown from MI varieties is certified seed production.
MCIA is the Vital Foundation Seed Link Between University Breeders and Certified Seed Producers

“MCIA’s Foundation Seed Division is dedicated to serving the seed industry through the production of genetically pure Foundation Seed. The Foundation Seed Division is the VITAL LINK between the University plant breeders and certified seed producers.”

MCIA History & Roles:
- Established 100 years ago to provide the link of distribution between university breeders and industry
- Provide feedback on desired new dry bean varieties from growers to university breeding program
- Sole provider of foundation seed for MSU dry bean varieties
- Collect royalties on foundation seed sales
- Acts as industry seed certifying agency
- Other crops served by MCIA include: Corn, Barley, Rye, Oats, Soybeans, Wheat, Peas

MCIA Leadership & Staff:
- Board of Directors Includes:
  - President and Vice President
  - MSU Representative
  - Industry Representative
  - Michigan Department of Agriculture Representative
  - Grower Representatives
- Association Staff Includes:
  - Foundation Seed Operations Manager
  - Office & Association Managers
  - Field Inspection Supervisor
  - Lab Manager & Lab Technician
  - Seed Processors & Supervisor
  - Foundation Seed Quality Manager

Foundation Seed Production Regions:
- WA
- ID
- WY
- MI

MCIA works with contracted seed companies in Western U.S. states to produce foundation seed separate from the disease pressures in Michigan

MCIA uses the Advance Seed Orders to direct the contract growers on how much foundation seed to produce.
MCIA is the Vital Foundation Seed Link Between University Breeders and Certified Seed Growers

**Foundation Seed Ordering Details:**

| Orders must be placed by certified seed growers one year in advance for guaranteed delivery |
| Certified seed growers are responsible for 50% of their seed order. MCIA has exposure for the other 50% if not purchased by the seed grower |
| Seed order forms are found on MCIA’s website and the grower must mail or fax the form to MCIA directly |
| Seed orders can be made via phone, however MCIA requires a signed copy of conditions for each seed order |
| Foundation Seed is available to growers in 50 lb. bags, 2,000 lb. tote bags, or in bulk |

**Foundation Seed Supply Planning Details:**

| Foundation seed production is managed by MCIA and facilitated through four seed companies in Western U.S. states |
| MCIA Foundation Seed Operations Manager (Jim Palmer) directs seed company inventory planners on how much foundation seed to produce to meet the Advanced Orders for the following year |
| MCIA Foundation Seed Operations Manager receives Advanced Certified Seed orders from certified seed growers |
| Seed companies produce foundation seed based on MCIA direction |
| MCIA distributes foundation seed based on Advance Orders to certified Seed growers |
| In the case of foundation seed production underages, MCIA allocates foundation seed to certified seed companies based on their 3-5 year average order applied to the percentage of total demand that was produced |
MCIA is the Acting Royalty Collection Agency

<table>
<thead>
<tr>
<th>Royalty Collection Methods Have Evolved Over Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The Original Collection Method:</strong></td>
</tr>
<tr>
<td>- Royalties used to be collected on each grower’s reported certified seed sales</td>
</tr>
<tr>
<td>- Growers would report number of certified seed bags sold and pay a royalty of ~$5/100lb of seed</td>
</tr>
<tr>
<td>- In-state (Michigan), seed companies may still opt to use this method of royalty collection</td>
</tr>
<tr>
<td><strong>The Issue:</strong></td>
</tr>
<tr>
<td>- It became increasingly difficult to collect royalties on all bags sold by certified seed growers</td>
</tr>
<tr>
<td>- Large volumes of seed were being sold, but volumes were underreported for royalty collection by MCIA</td>
</tr>
<tr>
<td>- Out-of-state production of certified seed makes collection even more difficult for MCIA</td>
</tr>
<tr>
<td><strong>Today’s Royalty Collection Solution:</strong></td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
</tbody>
</table>
MCIA Royalty Collection Methods and Financing Details

MCIA is a Self-Sustaining Non-Profit Organization:

**MCIA’s Foundation Seed Agency pays for the increase of MSU Dry Bean Breeding and Genetics Program’s breeder seed to foundation seed levels**

**Seed increase activities are fully funded through sales of Foundation Seed to Certified Seed companies (seed price x units sold)**

**MCIA’s foundation seed sales generate enough income to run the program and cover all operational costs**

**MCIA raises prices on foundation seed as needed.** In 2014, the price was raised from $120/cwt to $125/cwt. In January 2018, foundation seed prices were increased another 5%.

**Dry Bean Foundation Seed sales generate 65% of overall revenues for MCIA’s Foundation Seed Agency**
Commodity trading companies, which are also known as grain elevators, are vertically integrated into seed and commodity production. An estimated 90% of Michigan dry bean production is contracted by commodity trading companies.

Commodity trading companies sell the certified seed that they produce to Michigan growers, who are contracted to sell back their production.
Dry Bean Production Process

The Michigan Bean Commission published the following video in January of 2018 that visually documents key steps in the production process, including: seed selection, production contracting, field cultivation, commodity delivery, inspection, and packaging of key value chain steps.

Video Link: http://michiganbean.org/michigan-bean-production/
Financial Sustainability
Financial Sustainability by EGS Value-Chain Step

**Varietal Development**
- Managed by a State University
- 18% Financially Self-Sustaining

**Foundation Seed Production**
- Managed by a Nonprofit
- 100% Financially Self-Sustaining

**Certified Seed Production**
- Managed by Private Sector
- 100% Financially Self-Sustaining

Source: Stakeholder Interviews with the MSU Dry Bean and Genetics Program
Key Seed System Funding Mechanisms

**GRANTS:** Fund focused breeding program initiatives, not operational overhead costs.

**Royalty Fees:** Certified seed growers pay a royalty based on the volume of foundation seed they purchase. MCIA collects the royalty amount, and remits it to MSU in accordance with its licensee responsibilities. Royalties are allocated in one third increments.

*Royalty fees vary by class, with smaller sized seed classes (e.g., black beans and navy beans), commanding a higher prices per cwt.*

- 1/3 allocated to **variety breeder** who can choose whether to distribute it to the program or to individual team members. Kelly often opts to distribute it to his program.
- 1/3 allocated to **MSU Department of Plant, Soil and Microbial Sciences** for use in development and improvement of programs. Dr. Kelly receives ~50% of this funding for the breeding program.
- 1/3 allocated to **MSU Foundation** for support of university research and technology initiatives.

**Check Off Funds:** Funds research and marketing

- Revenue managed by the Michigan Bean Commission
- Renewed every 5 years by grower referenda
- $0.10 per hundredweight of beans sold

- **$0.09** allocated to **industry marketing**
- **$0.01** allocated to **research & is matched by the Michigan Bean Shippers**
- Funds **industry agronomist**
Varietal Development and Foundation Seed Production is Largely Subsidized by the Public Sector

The public sector subsidizes the MSU Dry Bean Breeding and Genetics Program, which underpins the Michigan dry bean industry.

MSU Dry Bean Breeding and Genetics Program’s estimated annual operating costs, excluding researcher salaries and the rent, repair, and depreciation expenses associated with the publicly owned buildings and equipment that it utilizes.

Operational costs are augmented by royalties collected on licensed MSU varieties and from sponsored research projects.

Royalties on the sale of MSU licensed dry beans contributes less than 20% of the Bean Breeding and Genetics Program’s annual operating budget.
Foundation Seed Demand Forecasting, Production, and Delivery is Managed by a Nonprofit

MCIA’s ability to effectively manage demand planning through constant communication with growers and the industry has enabled its status as a financially self-sustaining, nonprofit.

MCIA adds value to the dry bean industry by assuming exposure to the risk of errant demand projections by certified seed companies. In the absence of MCIA, the public and private sector would have to assume the commercially unattractive functions of dry bean early generation seed multiplication and certification.

Combined revenue from dry bean foundation seed sales (98%) and dry bean certified field inspection fees (2%) in the State of Michigan

While not included in the above analysis, MCIA also sells dry bean foundation seed to out-of-state certified seed growers.

SOURCE: Stakeholder Interviews with the MSU Dry Bean and Genetics Program
Early Generation Seed Subsidization Enables Profitable Certified and Commercial Dry Bean Production in the State of Michigan

A small number (~3) of certified seed companies contract the production of certified seed, which is purchased and planted on 90% of Michigan’s dry bean acres.

The Michigan Bean Commission estimated the economic impact of dry bean farming to be over $270 million, and that 1,770 jobs created by the industry (1,120 directly in farming and 650 employed in related industries).

Certified Seed & Dry Bean Revenue Estimates

(1) SOURCE: Industry Stakeholder Interviews
(2) SOURCE: Michigan Bean Commission based on average estimated economic impact between 2011 and 2013
(3) SOURCE: Stakeholder Interviews
In 2014-15, $60M in State Funding for Research and Extension was Leveraged to Create Over $1B in Statewide Impact

Every dollar the State of Michigan invested in MSU AgBioResearch and MSU Extension resulted in an estimated additional:

- **$2.59** in federal funds and external contracts, grants and other revenues to serve Michigan residents
- **$6.37** in additional community benefits
- **$8.07** in economic stimulus is state economic activity and state tax revenues

**SOURCE:** 2014-15 Legislative Report for MSU AgBioResearch and MSU Extension
Enabling Environment
MSU Extension Outreach

MISSION: “MSU Extension works to increase farmers’ success while protecting the environment, ensuring food safety, reaching new markets and advancing agriculture through applied research. Agriculture is now one of the fastest growing sectors of the Michigan economy.” MSU Extension Agriculture

EXAMPLES OF INDUSTRY OUTREACH:

Late winter dry bean update held Feb. 28, 2018

Growers will hear from MSU and industry experts on a variety of pest, production and marketing issues.

Posted on February 20, 2018 by Fred Springer, Michigan State University Extension

Michigan State University Extension will host a free, online Late Winter Dry Bean Production Update at 1 p.m. on Feb. 28, 2018. You will have the option of attending from the comfort of your home or office by following this link: https://msu.ca.uky.edu/13282/15614.

You can also come to one of the following two locations to view the online meeting and interact with the speakers:

MSU Extension Isabella County
27 Foot Room 450
200 N. Main St.
Mt. Pleasant, MI 48858

MSU Extension Delta County
2410 College Ave.
Escanaba, MI 49829

The agenda for the day includes:

- MSU bean breeders update — Jim Kelly, MSU Plant, Soil and Microbial Sciences
- Pathology research — Martin O’Brien, MSU Plant, Soil and Microbial Sciences
- Wheat and soybean disease updates — Fred Springer, MSU Extension
- PRAB (Production Research Advisory Board) update — Greg Vanter, Michigan Bean Commission
- Market update — Larry Sprague, Ketyl Bean Company

Participants at the in-person sites will be eligible to receive three Restricted Use Pesticide credits.

This article was published by Michigan State University Extension. For more information, visit http://www.msu.ca.uky.edu. To have a digest of information delivered straight to your email inbox, visit http://www.msu.ca.uky.edu/newsletters. To contact an expert in your area, visit http://contact.msu.ca.uky.edu or call 888-MN-BMI (888-678-3494).
U.S. Land-Grant Institution Overview

“Teach such branches of learning as are related to agriculture and the mechanic arts . . . in order to promote the liberal and practical education of the industrial classes.” -Morrill Act 1862

U.S. Land-Grant Universities Were Founded Based on Three Principle Functions, Which Continue to Drive Them Today:

<table>
<thead>
<tr>
<th>Teaching</th>
<th>Research</th>
<th>Cooperative Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td>The First Morrill Act (1862) provided grants in the form of federal lands to each state. States sold these lands and established public institutions with the proceeds. The goal of land-grant universities was initially to meet the increasing demand for agricultural and mechanical education. Currently, land-grant universities continue to offer education programs centered on agriculture and engineering.</td>
<td>The Hatch Act (1887) authorized direct payment of federal grants to each state to establish agricultural experiment stations. Funding remains in place today for these programs. A major portion of federal funds invested must be matched by state funding.</td>
<td>The Smith-Lever Act (1914) created the Cooperative Extension Program within each land-grand institution to disseminate research findings from the agricultural experiment stations. The act authorized ongoing federal support (matched by state support) for the Cooperative Extension Systems, which still exists for extension programs today.</td>
</tr>
</tbody>
</table>

The USDA plays a large role in the allocation of funds for each function of the U.S. land-grant university system. These funds are essential to assure that the functions of the universities can continue to benefit all industries, including the agricultural industry.

“The Morrill Act symbolizes the public trust that has given life to our nation’s entire educational system for the past 150 years—and it reminds us all of the public commitment that will be necessary for the system to thrive for 150 more.”

–Christopher P. Loss, Vanderbilt University

SOURCE: http://www.aplu.org/about-us/history-of-aplu/what-is-a-land-grant-university/
Land-Grant Colleges and Universities in the United States
thank you
Appendix
### Acknowledgments

Thank you for your time and support in the development of the MSU Dry Beans EGS profile!

# Key Stakeholders Interviewed

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Jim Kelly</td>
<td>University Distinguished Professor &amp; Bean Breeder</td>
<td>MSU Dry Bean Breeding and Genetics Program</td>
</tr>
<tr>
<td>Dr. Douglas Buhler</td>
<td>Director</td>
<td>MSU AgBioResearch</td>
</tr>
<tr>
<td>Dr. Irvin Widders</td>
<td>Director</td>
<td>Legume Innovation Lab-MSU</td>
</tr>
<tr>
<td>Mr. Jim Palmer</td>
<td>Foundation Seed Operations Manager</td>
<td>Michigan Crop Improvement Association</td>
</tr>
<tr>
<td>Mr. Paul Varner</td>
<td>Former Co-Owner</td>
<td>Treasure Valley Seed Co.</td>
</tr>
<tr>
<td>Mr. Greg Varner</td>
<td>Research Director</td>
<td>Michigan Bean Commission</td>
</tr>
<tr>
<td>Dr. Tom Herlache</td>
<td>Technology Manager &amp; Asst. Director for Commercialization</td>
<td>MSU Technologies</td>
</tr>
<tr>
<td>Mr. Dan Hensler</td>
<td>Marketer</td>
<td>ADM</td>
</tr>
</tbody>
</table>
Dry Beans
Michigan

Crop Insured
You can insure dry beans if:
- Premium rates are provided;
- They are grown on insurable acreage;
- You have a share;
- They are planted in rows wide enough to allow cultivation; and
- They are intended for harvest as dry beans.

Counties Available
Dry Beans are insurable in Alcona, Alger, Arenac, Bay, Clinton, Delta, Eaton, Genesee, Gladwin, Gratiot, Huron, Ingham, Ionia, Jackson, Isabella, Kalamazoo, Kent, Lake, Macomb, Midland, Montcalm, Muskegon, Presque Isle, Saginaw, Sanilac, Shiawassee, St. Clair, and Tuscola Counties.

Causes of Loss
You are protected against the following:
- Adverse weather;
- Earthquake;
- Failure of irrigation water supply;
- Fire;
- Insect damage and/or plant disease, unless you have insufficiently or improperly applied pest or disease control measures;
- Volcano eruption; or
- Wildlife.

Insurance Period
Coverage begins on the later of:
- The date we accept your application, or
- The date you plant the beans.
Coverage ends at the earliest of:
- Total destruction of the crop;
- Harvest of the crop;
- Final adjustment of a loss; or
- October 31, 2017.

Important Dates
Sales Closing/Cancellation: March 15, 2017
Final Planting: June 25, 2017
Acreage Report: July 15, 2017

Reporting Requirements
You must report all of your dry bean acreage, production, and any losses, when evident, to your insurance agent.

Revenue Protection
- Protects against loss of revenue due to a production loss, change in price, or a combination of both.

Revenue Protection with Harvest Price
Exclusion - Protects against loss of revenue due to a production loss, price decline, or a combination of both.

Revenue Protection with Harvest Price
Exclusion - Protects against loss of revenue due to a production loss, price decline, or a combination of both.

Catastrophic Risk Protection Coverage (CAP)
Available only with yield protection. Pays 50 percent of your average yield and 55 percent of the projected price. CAP has no premium but does have a $300 administrative fee per crop per county.

Replanting and Prevented Planting
Practical to Replant - Your company will determine it is practical to replant. The processor must agree, in writing, that it will accept production from replanted acreage.

Replant Provisions
You may receive a replant payment if:
- It is practical to replant;
- The appraisal does not exceed 90 percent of your production guarantee.

Replant payments are not available on CAT coverage.

Late Planting Period - If you choose to plant after the final planting date, the insurance guarantee is reduced by one percent for each day after the final planting date. After 25 days, the guarantee is 60 percent.

Prevented Planting - You may receive a prevented planting payment if you are unable to plant on or before the final planting date because of an insurable cause.

Loss Example
Yield Protection Example - This example assumes 1,600 pounds/acre APH yield for soybean type, 65 percent coverage level, and basic unit coverage.
1,600 pounds/acre APH yield X 0.65 coverage level = 1,040 pound guarantee

$100 per unit = $100 X 1,040 pounds = $104,000 yield loss

$300 per unit = $300 X 1,040 pounds = $312,000 yield loss

Revenue Protection Example:
- 1,040 pound guarantee
- $100.20 projected price

Revenue Protection with Harvest Price
- 700 pounds/acre produced
- $100.20 per unit

Where to Buy Crop Insurance
You can buy a crop insurance policy from approved participating insurance agents. A list of crop insurance agents is available at all USDA service centers and on the RMA website at www.rma.usda.gov/agents/agent.html.

Contact Us
USDA/RMA
Springfield Regional Office
3300 Wabash Avenue
Springfield, IL 62711
Phone: (217) 241-6600
Fax: (217) 241-6618
Email: rmaillinois@rma.usda.gov

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status,收养状态，宗教，性取向，性别认同，政治信仰，赔偿，或因为全部或部分是个人收入是来源于任何公共援助计划。（Portion of prohibited bases apply to all programs.）个人与残疾的人可能选择使用替代方式来获取公务活动信息（手语，音符，等）。欲知更多信息，请联系USDA的TDD Target Center: 202-720-0000 (voice and TDD).

To file a complaint with USDA regarding discrimination, complete, sign and mail a program discrimination complaint form (available at any USDA office location or online at www.ascr.usda.gov), to USDA's Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410; or call toll-free at (866) 632-9992 (voice) or (800) 09992 (TDD). The USDA shall provide reasonable accommodation to individuals with disabilities where appropriate.USDARMA. Please contact USDA's Target Center at (800) 877-8339 (voice) or (800) 846-6136.
The Michigan Seed Industry Is Subject to State and Federal Law

**INTERSTATE & FOREIGN**

*Federal Seed Act*
An Act to regulate interstate and foreign commerce in seeds; to require labeling and to prevent misrepresentation of seeds in interstate commerce; to require certain standards with respect to certain imported seeds; and for other purposes.\(^1\)

---

**MICHIGAN**

*The Michigan Seed Law of 1965*
"An Act to regulate the labeling, coloration, advertising, sale, offering, exposing, or transporting for sale of agricultural, vegetable, lawn, flower, and forest tree seeds; to authorize the director of agriculture to adopt rules for the enforcement of this act; to provide for the inspection and testing of seed; to prescribe license fees; to preempt ordinances prohibiting or regulating certain activities with respect to seeds; and to prescribe penalties for violation of this act."

Primary to ASTA’s state legislative agenda is to ensure that state regulations relating to the seed industry remain consistent between the states. This allows for smoother interstate trade, equalized competition, and elimination of unnecessary, duplicative and burdensome regulations. The Recommended Uniform State Seed Law (RUSSL) is the preferred model for state seed regulations.\(^3\)

---

Dry Bean Seed Produced in Michigan is Required to be Field Inspected and Laboratory Tested

**286.707a Field beans.** Sec. 7a. (1) Field bean seed produced east of a line dividing the central and mountain time zones and sold or offered for sale in Michigan, including seed offered for sale by its producer, shall be field inspected and laboratory tested for seed borne diseases including, but not limited to, common blight (Xanthomonas phaseoli), fuscous blight (Xanthomonas phaseoli var. fuscans), halo blight (Pseudomonas phaseolicola), and anthracnose (Colletotrichum lindemuthianum), which are determined by the director to be a threat to the bean industry. The director may inspect and test seed, from other sources as necessary, to determine the presence of or freedom from seed borne diseases. (2) The director shall approve standards, tolerances, methods, procedures, and protocols employed in field inspections and laboratory tests of field beans. The field inspections and laboratory tests for disease approved by the director shall be at least equal to those field inspections and laboratory tests utilized for certified seed under Act No. 221 of the Public Acts of 1959, being sections 286.71 to 286.75 of the Michigan Compiled Laws, and rules promulgated under that act. The director may modify those standards, tolerances, methods, procedures, and protocols described in this subsection if their application would threaten the normal propagation of a type or variety of field bean seed. (3) In the case of field beans sold by variety name, the director may waive the requirement of inspection and analysis relative to a specific field bean disease if it is determined by the director that, through consultation with Michigan state university or other authorities recognized by the director, the variety is resistant to 1 or more specific field bean diseases. (4) The director shall take enforcement action against any seed lots which he or she determines to be infected. History: Add. 1996, Act 86, Imd. Eff. Feb. 27, 1996.
Plant Variety Protection for seeds is issued by the Plant Variety Protection Office of the USDA AGRICULTURAL MARKETING SERVICE.

Seed varieties are protected from unauthorized distribution for 20 YEARS.

Policy assures that seed varieties CANNOT BE SOLD in any form by anyone other than MSU or MSU licensees.

<table>
<thead>
<tr>
<th>USDA’s Plant Variety Protection program helps to protect the varieties that MSU develops:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grower ability to easily sell seed varieties without authorization THREATENS THE PURITY of the variety</td>
</tr>
<tr>
<td>Ensuring that growers can only buy seed from certified sources helps PRESERVE THE CERTIFIED SEED QUALITY</td>
</tr>
<tr>
<td>Protection also ensures that ROYALTIES are being duly paid through the CORRECT CHANNELS</td>
</tr>
</tbody>
</table>

SOURCE: https://www.ams.usda.gov/services/plant-variety-protection
The Plant Variety Protection Office (PVPO) provides intellectual property protection to breeders of new varieties of seeds and tubers. Implementing the Plant Variety Protection Act (PVPA), we examine new applications and grant certificates that protect varieties for 20 years (25 years for vines and trees). Our certificates are recognized worldwide and allow faster filing of PVP in other countries. Certificate owners have rights to exclude others from marketing and selling their varieties, manage the use of their varieties by other breeders, and enjoy legal protection of their work.

In the U.S. there are 3 types of intellectual property protection that breeders can obtain for new plant varieties:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable to:</td>
<td>Plant, plant part, gene, protein, method, etc.</td>
<td>Asexually propagated plant and its asexually propagated progeny</td>
<td>Sexually (seed), propagated plant varieties</td>
</tr>
<tr>
<td>Rights to Exclude Others From:</td>
<td>Making, using, selling, offering for sale and importing the plant, or any of its parts</td>
<td>Making, using, selling, offering for sale and importing the plant, or any of its parts</td>
<td>Selling, marketing, conditioning, stocking, offering for sale, reproducing, importing, or exporting, using the variety to produce (as distinguished from develop), a hybrid or different variety</td>
</tr>
<tr>
<td>Terms of Protection:</td>
<td>20 year term from date of filing</td>
<td>20 year term from date of filing</td>
<td>20 year term (25 years for trees or vines), from issuance of the certificate</td>
</tr>
<tr>
<td>Exemption:</td>
<td></td>
<td></td>
<td>A person (farmer), may save seeds for planting on the person’s land, but may not transfer to others for seed reproduction purposes</td>
</tr>
</tbody>
</table>

Abstract: Public plant breeders at land grant universities and USDA play a critical role in the development of improved cultivars for farmers in the United States. Over the past 20 yr, a series of reports have documented the decrease in public plant breeding programs, breeder positions, and government financial support. Publicly funded programs allow breeders to focus on crop types, geographic locations, and management systems that are not sufficiently profitable to warrant significant investment from private industry. A survey was conducted in 2015 to understand the current state of cultivar development in the U.S. public sector. The survey respondents were public plant breeders actively releasing finished cultivars and inbred lines, and questions included: (i) demographic and background information; (ii) germplasm usage and exchange; (iii) intellectual property rights; (iv) breeding program funding; (v) institutional support and program size. Results indicate that public cultivar development is in a state of decline, with insufficient numbers of younger breeders working in the public sector today to maintain the current level of cultivar development as the most senior breeders retire. Funding public breeding programs continues to be a challenge, as is access to improved germplasm due to overly restrictive licensing agreements. Potential opportunities include redistribution of royalty funds to bolster revenue streams, and simplifying the germplasm exchange process to increase the likelihood of successful cultivar releases.

Conclusion: Public plant breeders play a critical role in determining the future of agriculture. Their work is varied, and includes long-term research in areas such as assessing and broadening genetic diversity, introgression of traits from wild species, development of new breeding methodologies, and expanding applications for genomic tools. Public plant breeders are responsible for the education of the next generation of plant breeders (both public and private), and require active breeding programs to provide hands-on learning for students, from initial crosses through the release process. In this study, we have focused on their role in cultivar development. Plant breeders in the public sector often focus on minor crops, cover crops, perennial crops, and geographies and farming systems that are under-served by the private sector. By improving these crops, regions and systems with well-adapted varieties, public plant breeders create a more resilient agricultural landscape that buffers against the increasing climactic and economic fluctuations of the 21st century. Yet plant breeding in the public sector is in a current state of crisis due to lack of sufficient funding to support this public good. In addition, the increasing use of restrictive IP limits public plant breeders’ access to useful germplasm necessary for the development of improved cultivars. Public plant breeders have an opportunity to address this challenge by working with their universities and technology licensing offices, and one another to reduce the restrictive nature of their licensing agreements, especially for germplasm exchange with other public programs, and by redistributing royalty money allocations to increase support directly for cultivar development.

Public Plant Breeder Respondent Distribution by...

**Institution**
- Land-Grant University/State Agricultural Experiment Station, 159, 84%
- USDA–Agricultural Research Service, 31, 16%

**Crop Type**
- Field crops 53%
- Vegetables and pulses 26%
- Fruits, nuts, trees, and ornamentals 21%

**Tenure**
- Yes 72%
- No 28%

**Crop Biology**
- Pure line, 82, 43%
- Hybrid, 40, 21%
- Clonal, 55, 29%
- Both hybrid and pure line, 14, 7%

Breeders Report Employing an Average of 8.4 Persons

All figures as percentages

- Undergraduate students: 2.9
- Graduate students: 2.2
- Field technicians: 1.7
- Lab technicians: 0.7
- Post-doctoral students: 0.5
- Other: 0.4

Breeding Programs Encourage and Incentivize Cultivar Development, But Only 43% of Breeders Report That Their Position Would Be Replaced if they Left

“If you work for an institution that offers tenure, does cultivar development count towards the tenure process?”

“If you were to leave your job for any reason, will your position be replaced?”

Breeders Most Commonly Source Germplasm From Other Public Breeding Programs

"Which of the following germplasm sources do you use the most?"

- Other Public Breeding Programs: 49.4%
- USDA GRIN: 24.7%
- Wild Collections: 9.0%
- Other: 6.2%
- Private Industry: 5.6%
- Internal Program Inventory: 2.8%
- CGIAR: 2.3%
Positive Correlation Between Years Worked as a Public Plant Breeder and the Number of Cultivars Released

How many years have you worked as a plant breeder?

Number of cultivars released by number of years worked as a public plant breeder

Breeders’ Employers Contribute Less Than 25% of Annual Operating Costs

Mean percentage distribution of funding sources for breeding programs based on public plant breeder respondents releasing finished cultivars (including inbred lines) and surveyed in 2015 (N = 177).

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>% of Breeding Program Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employer</td>
<td>24.1</td>
</tr>
<tr>
<td>Commodity check-off programs</td>
<td>17.8</td>
</tr>
<tr>
<td>USDA competitive grants</td>
<td>14.2</td>
</tr>
<tr>
<td>Royalty money</td>
<td>12.3</td>
</tr>
<tr>
<td>Private industry</td>
<td>12.3</td>
</tr>
<tr>
<td>Federal formula funds</td>
<td>11.6</td>
</tr>
<tr>
<td>Other</td>
<td>7.6</td>
</tr>
</tbody>
</table>

65.9% of Respondents Report Operating Costs Below $300,000

Regardless of Crop Type, Breeding Programs’ Average Annual Operating Costs is Reported to be Below $300K

Majority of Respondents Indicate That Their Breeding Program is Under-Funded

<table>
<thead>
<tr>
<th>Breeding Programs by Annual Operating Costs</th>
<th>Less than $100,000</th>
<th>$100,000–$199,999</th>
<th>$200,000–$299,999</th>
<th>$300,000–$399,999</th>
<th>$400,000–$499,999</th>
<th>$500,000 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>100</td>
<td>37</td>
<td>48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you feel your program is:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very or somewhat under-funded</td>
<td>34.0</td>
<td>30.0</td>
<td>17.0</td>
<td>10.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Neither under nor well funded</td>
<td>13.5</td>
<td>27.0</td>
<td>18.9</td>
<td>8.1</td>
<td>16.2</td>
<td>16.2</td>
</tr>
<tr>
<td>Very or somewhat well funded</td>
<td>6.3</td>
<td>10.4</td>
<td>22.9</td>
<td>12.5</td>
<td>20.8</td>
<td>27.1</td>
</tr>
<tr>
<td>Does your program generate royalties?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>133</td>
<td>15.8</td>
<td>22.6</td>
<td>22.6</td>
<td>9.8</td>
<td>13.5</td>
</tr>
<tr>
<td>No</td>
<td>48</td>
<td>43.8</td>
<td>31.3</td>
<td>4.2</td>
<td>12.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Satisfaction with royalty distribution:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very or somewhat dissatisfied</td>
<td>43</td>
<td>14.0</td>
<td>18.6</td>
<td>16.3</td>
<td>18.6</td>
<td>18.6</td>
</tr>
<tr>
<td>Neither dissatisfied nor satisfied</td>
<td>23</td>
<td>8.7</td>
<td>30.4</td>
<td>21.7</td>
<td>0.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Very or somewhat satisfied</td>
<td>62</td>
<td>19.4</td>
<td>22.6</td>
<td>25.8</td>
<td>6.5</td>
<td>11.3</td>
</tr>
</tbody>
</table>

All figures as percentages

Respondents Believe Grants Have a Larger Influence on the Focus of Breeding Work Than Private Industry

Table 8. Impact of funding sources on focus of breeding work reported by public plant breeder respondents releasing finished cultivars (including inbred lines), and surveyed in 2015.

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Industry</td>
<td>29.0</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td></td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>Not at all</td>
</tr>
<tr>
<td>Royalties</td>
<td>62.9</td>
</tr>
</tbody>
</table>

All figures as percentages

Intellectual Property Rights Are Routinely Secured on Public Breeders’ Cultivars

Likelihood of usage of various forms of intellectual property rights to protect cultivars (including inbred lines) released by public plant breeder respondents and surveyed in 2015.

<table>
<thead>
<tr>
<th>Form of intellectual property rights</th>
<th>Field crops</th>
<th>Fruits, nuts, trees, ornamentals</th>
<th>Vegetables and pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>License</td>
<td>78.2</td>
<td>77.1</td>
<td>79.4</td>
</tr>
<tr>
<td>Plant variety protection certificate</td>
<td>85.4</td>
<td>34.4</td>
<td>85.3</td>
</tr>
<tr>
<td>Plant patent</td>
<td>12.5</td>
<td>86.5</td>
<td>9.7</td>
</tr>
<tr>
<td>Trademark</td>
<td>11.1</td>
<td>65.7</td>
<td>25.8</td>
</tr>
<tr>
<td>Utility patent</td>
<td>20.9</td>
<td>3.3</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Breeders Commonly Share Germplasm (95%), but the Associated Material Transfer Agreements Restrict Breeders’ Freedom to Operate

How do often does germplasm leave your institution with a material transfer agreement (MTA)?

- Always: 26%
- Mostly: 35%
- Sometimes: 26%
- Rarely: 7%
- Never: 6%

How does the language of the MTA that you receive impact your freedom to operate as a plant breeder?

- Strongly restricts: 15%
- Somewhat restricts: 53%
- Neither restricts nor improves: 28%
- Somewhat improves: 2%
- Strongly improves: 2%