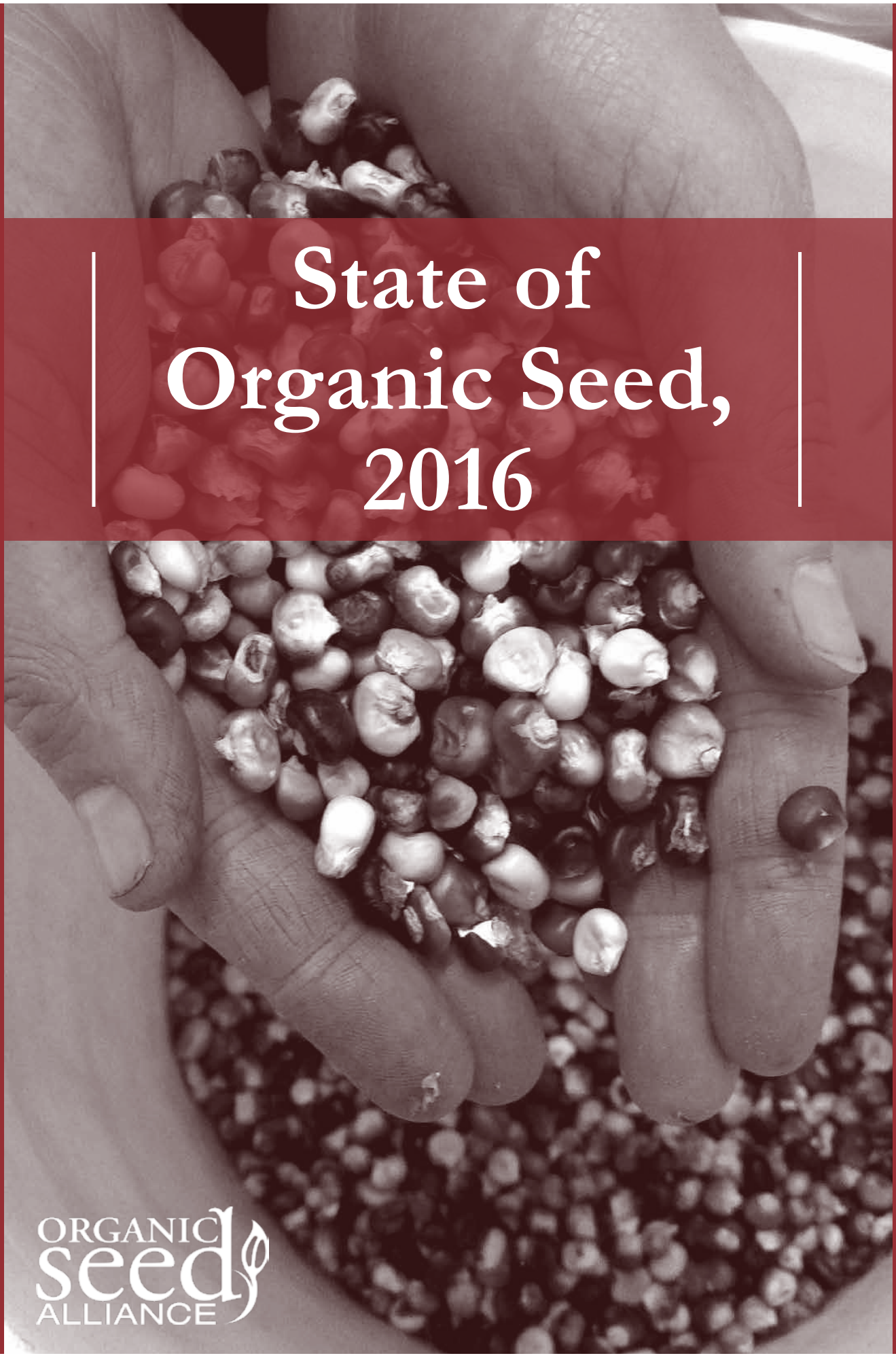
State of Organic Seed, 2016



ORGANIC seed ALLIANCE

State of Organic Seed, 2016

Kristina Hubbard and Jared Zystro

June 2016

ACKNOWLEDGMENTS

The authors are grateful to the following individuals who served on our farmer survey planning committee:

Harriet Behar, Midwest Organic and Sustainable Education Service
Matthew Dillon, Clif Bar & Company
John Foster, Earthbound
Nate Lewis, Organic Trade Association
Alex Lyon, University of Wisconsin-Madison
James Myers, Oregon State University
John Navazio, Johnny's Selected Seeds
Erica Renaud, Vitalis Organic Seeds
Elia Romano, Albert Lea Seed House
Margaret Scoles, Independent Organic Inspectors Association
Zea Sonnabend, California Certified Organic Farmers
Adam Wagner, Organically Grown Company
Ira Wallace, Southern Exposure Seed Exchange

We also thank the following agencies, businesses, and organizations for distributing our farmer survey. We wouldn't have been able to collect this data without their assistance.

Accredited Certifiers Association, Agricultural Services Certified Organic, California Certified Organic Farmers, Department of Plant and Industry/Clemson University, EcoFarm, Farm Aid, Florida Organic Growers, Georgia Organics, Global Organic Alliance, Inc., International Certification Services, Inc., Midwest Organic Farmers Cooperative, Midwest Organic and Sustainable Education Service, Minnesota Crop Improvement Association, Montana Department of Agriculture, National Organic Coalition, Natural Food Certifiers, New Hampshire Department of Agriculture, New Jersey Department of Agriculture, New Mexico Organic Commodity Commission, Nevada Department of Agriculture, Northeast Organic Farming Association, Northeast Organic Farming Association—New York Certified Organic, Northeast Organic Farming Association—Vermont Organic Farmers, Northern Plains Sustainable Agriculture Society, Ohio Ecological Food and Farm Association, Oregon Department of Agriculture, Oregon Tilth, Organic Crop Improvement Association, Organic Farmers' Agency for Relationship Marketing, Organic Farming Research Foundation, Organic Trade Association, Organic Valley, Organically Grown Company, Pennsylvania Certified Organic, Pennsylvania Association for Sustainable Agriculture, Practical Farmers of Iowa, Quality Certification Services, Rhode Island Department of Environmental Management, Rural Advancement Foundation International, Tilth Producers of Washington, Washington Sustainable Food & Farming Network.

Thank you to the National Organic Program for promoting the farmer survey and for its enthusiasm toward this project.

We are also grateful to the following individuals for reviewing an earlier draft of this report:

Heron Breen, Fedco Seeds
Matthew Dillon, Clif Bar & Company
Mac Ehrhardt, Albert Lea Seed House
Erica Renaud, Vitalis Organic Seeds
Adrienne Shelton, Seed Matters Fellow
Tom Stearns, High Mowing Organic Seeds
Bill Tracy, University of Wisconsin-Madison
Abby Youngblood, National Organic Coalition

We'd like to thank everyone who participated in one of our eight listening sessions held at the conferences listed below. Thanks to the following individuals for their assistance in planning and facilitating some of these sessions: Michael Mazourek and Michael Glos, Cornell University; Ginny Moore, University of Wisconsin-Madison; Laura Lewis, Washington State University; Suzanne Stone, University of Georgia; and Ken Greene, Hudson Valley Seed Library.

Carolina Farm Stewardship Association (2014)
EcoFarm (2015)
Georgia Organics Conference & Expo (2015)
National Young Farmers Coalition (2014)
Northeast Organic Farming Association – New York Conference (2015)
Organicology (2015)
San Juan Islands Agricultural Summit (2015)
Tilth Producers of Washington (2014)

Thank you to Marie-Eve Levert, strategy & research manager for the Canada Organic Trade Association. Marie-Eve provided guidance on our organic certifier survey based on her experience researching and writing the first market study of organic seed in Canada, *The Market for Organic and Ecological Seed in Canada: Trends and Opportunities, 2014*. She allowed us to repeat some of the questions used in their certifier survey. Thanks also to Jackie Sleeper of Oregon Tilth and Zea Sonnabend of California Certified Organic Farmers for their input on this survey.

Thanks to OSA interns Caitlin Moore, Ellie Costello, and Kelli Slater for helping with various surveys and providing valuable research assistance.

We want to acknowledge the tremendous support of OSA staff members: Brook Brouwer, Micaela Colley, Katy Davis, Tony Kleese, Cathleen McCluskey, Laurie McKenzie, Steve Peters, and Jennifer Turney.

Finally, this project wouldn't be possible without the generous financial support of the Clif Bar Family Foundation's Seed Matters initiative, the UNFI Foundation, and New Belgium Brewing Company. This project received no seed industry funding.

Please contact Kristina Hubbard at kristina@seedalliance.org with any questions or for more information about the report. Electronic copies can be downloaded at www.stateoforganicseed.org. Physical copies are available by donation.

Table of Contents

Executive Summary

Organic Seed Alliance's (OSA) *State of Organic Seed, 2016* is part of an ongoing project to monitor the status of organic seed systems in the US. Our 2011 findings provided the first comprehensive needs assessment for developing these systems. We're committed to measuring progress every five years, and this report serves as our first update.

The USDA's National Organic Program (NOP) requires the use of organic seed when commercially available. However, the organic seed sector was almost nonexistent when the program began and is still working to meet demand. Meanwhile, the organic food industry continues to grow, with sales toppling $39 billion in 2015. This makes our work to develop organic seed systems that respond to the needs of organic farmers and the diverse markets they serve that much more urgent.

We're making progress according to our newest findings. We arrived at this conclusion through a number of surveys and other forms of data collection, including a full analysis of research investments over the last five years. We surveyed organic farmers, organic seed companies, and organic certifiers to better understand barriers to expanding organic seed systems from a seed sourcing, seed production, and regulation enforcement standpoint, respectively. And we gathered input from additional stakeholders at eight organic farming conferences across the US in 2014 and 2015.

The purpose of our State of Organic Seed project is to measure the progress we're making in increasing the availability, quality, and integrity of organic seed. We envision an organic food system built on a foundation of organic seed. This report serves as an important summary of ongoing challenges to achieving this goal, and includes updated recommendations to guide research, education, and policy efforts for the next five years.

Why organic seed?

As a fundamental input in agriculture, seed serves as a farmer's first defense against pest, disease, and other production challenges. Seed genetics also largely dictate the quality and integrity of our food – from appearance to flavor to nutritional content. In this way, seed holds endless potential for transforming the food we eat and how we farm, especially when coupled with the principles that helped build the organic movement – the principles of health, ecology, fairness, and care.

But seed is much more than an input. It's a living, natural resource that demands careful management to ensure a secure and healthy food supply. Currently, the dominant seed system is controlled by a handful of chemical and biotechnology companies with no genuine interest in the success of organic agriculture. These players abuse intellectual property rights and fiercely protect them. They discourage farmers from participating in research and seed saving. And they put shareholder interests above those of the greater public.

As demand for organic products grows, so does demand for organic seed. As this report shows, the organic seed supply isn't keeping up with broader organic industry growth. Most organic farmers responding to our survey still rely on conventional (non-organic) seed for at least part of their operations.

Importantly, we found that farmers want to source organic seed to support investments in organic plant breeding. It's broadly accepted that organic systems provide different growing environments from conventional systems and that breeding crops under organic conditions can deliver varieties that increase the success of organic farmers and strengthen the organic integrity of their products. This is one of many benefits to expanding organic seed systems.

We believe the benefits of organic seed systems go well beyond helping organic farmers meet a regulatory requirement. An organic seed system – when viewed as an alternative to the dominant seed system – can help address bigger challenges in agriculture, including the preservation of crop genetic diversity and agricultural biodiversity; the privatization of seed and market consolidation; agricultural production fueled by high-input chemical systems that are toxic to humans and nature; genetic vulnerability in the seed and crops grown; nutritional deficiencies in the food supply; and social and economic injustices faced by farmers, plant breeders, and the communities they feed.

Therefore, the organic community has an opportunity to create a path for organic seed that is very distinct from the dominant system controlled by chemical and biotechnology companies. By establishing a shared vision and roadmap for developing organic seed systems, the organic community can avoid the negative trends seen in the conventional seed sector and conventional agriculture more broadly while delivering high-quality organic seed for all scales, crop types, and regions. This report helps monitor the progress we're making to achieve this vision.

Some key findings

It's clear that over the last five years the organic community and seed industry have made progress in increasing the availability, quality, and integrity of organic seed. This progress includes:

Organic farmers report using more organic seed Unfortunately, the biggest producers still use relatively little and this has a big impact on overall acres planted to organic seed.

Organic farmers are more satisfied with the organic seed they're using Farmers responding to our survey report fewer problems with organic seed compared to five years ago (e.g., germination, variety integrity, and seed-borne diseases). This finding was consistent across crop types.

More farmers believe organic seed is important to the integrity of organic food and that varieties bred for organic production are important to the success of organic agriculture This finding demonstrates an improved understanding among farmers that breeding crops in organic systems is important to their success and that of the broader organic industry.

A significant percentage of farmers save seed for either on-farm use or to sell commercially, indicating important opportunities to fill organic seed supply gaps The vast majority of farmers responding to our survey are interested in learning how to produce seed commercially. The lack of training, economic opportunity, and seed processing facilities were the top factors keeping farmers from growing organic seed commercially.

Public and private investments in organic plant breeding and other organic seed research have increased by $22 million in the last five years alone In our last report we documented a mere $9 million in investments between 1996 and 2010. This progress is encouraging, especially since it includes more diversity in funders. However, organic seed investments still pale in comparison to funding directed toward other sectors.

Despite this progress, challenges remain for expanding organic seed systems. We haven't seen major improvements in some areas. Some of the challenges include:

- Fewer organic certifiers are requesting that farmers increase their use of organic seed, and there is inconsistent enforcement of the organic seed requirement in general.

- Organic certifiers and inspectors lack training, resources, and strong guidance on organic seed availability, including a national organic seed database that includes full participation from the seed industry.
- Larger organic operations are still less likely to use organic seed.
- Buyer requirements remain a barrier to using organic seed for some of these larger operations.
- Forage crop growers haven't improved their use of organic seed.
- There remains a lack of experienced organic seed producers.
- Organic seed is more expensive to produce.
- Organic seed research, education, and policy work is underfunded.
- Some public and private breeders have limited access to appropriate germplasm for organic plant breeding projects.
- At times, intellectual property rights serve as a barrier for farmers, breeders, and seed companies.
- Public and private organic breeding programs need more infrastructure and capacity.
- The public is generally uneducated on the benefits of organic seed.
- There are inadequate policies and practices to protect organic seed from contamination by genetically engineered crops.

Recommendations

Building organic seed systems that are responsive to farmer and market needs will take collaborative and coordinated strategies in research, education, and policy. Below are the top five priorities from each of the chapters covering organic plant breeding, the organic seed supply, and organic seed policy. A full list of recommendations is included in the conclusion to serve as a roadmap for the next five years.

» Organic plant breeding

Increase public and private investments in organic plant breeding and other organic seed research While investments in organic breeding are on the rise, including investments from diverse funding sources, they're still insufficient to support more rapid increases in the diversity and quantity of organic seed available. Beyond breeding, there must also be more investment in research that supports organic seed production, management of seed-borne diseases, and other priorities identified by seed companies, researchers, and farmers producing organic seed.

Study and implement successful models, methods, and approaches to organic plant breeding Organic plant breeding requires different approaches because the production systems are different from their conventional counterparts, as are the values, principles, and regulations associated with organic agriculture.

Develop new, and expand existing, organic variety trial networks at the regional and national level Variety trials provide essential performance data to farmers and researchers but currently lack coordination in management, funding, and the dissemination of results.

Develop and promote fair intellectual property models These models shouldn't impinge on breeders' and farmers' rights while also allowing for returns on research investments to support future innovation.

Improve commercialization pipelines Mechanisms are needed to help new organic varieties get into the hands of farmers, including better networking between breeders and seed companies, coordination of testing networks, and streamlined intellectual property and royalty negotiations.

» Organic seed supply

Train more organic seed producers and support existing producers There's an urgent need to provide more formal training and resources to increase the number of organic seed producers in a variety of crops and at different scales.

Develop region-specific resources for production data and practices Organic seed producers need yield and economic data by crop type and region to support their success.

Create networks for organic seed producers and suppliers to support information and equipment sharing Organic seed producers are challenged by a lack of access to appropriate seed harvesting and cleaning equipment, and need more support with handling and storage.

Protect growers from the economic risks inherent to organic seed production Explore and encourage the use of organic crop insurance and other incentive programs to encourage farmers to integrate seed production into their organic farm plans.

Develop a public education campaign to promote organic seed Many organic seed stakeholders want to see an educational campaign directed at farmers, gardeners, and consumers about the benefits of organic seed, what goes into its development, and why it may have a higher price tag.

» Organic seed policy

Amend the National Organic Program's guidance document regarding organic seed The NOP should amend its March 2013 guidance document to provide more clarity and instruction that will ensure stronger and more consistent enforcement of the organic seed requirement, including holding accountable the operations that don't demonstrate continuous improvement in their organic seed sourcing.

Increase certifier and inspector trainings in organic seed Consistent enforcement of the organic seed requirement will require more guidance from the NOP; more resources available to certifiers, inspectors, and organic operators on organic seed availability; and regular trainings on how organic certifiers and inspectors can support increased sourcing of organic seed.

Improve regulations governing genetically engineered crops The US Department of Agriculture and other government agencies must improve regulations and oversight to alleviate the current burdens and costs currently associated with GE contamination in organic seed.

Address problems of market concentration and restrictive intellectual property rights At times, utility patents and other forms of intellectual property rights are abused at the expense of farmers', breeders', and seed companies' freedom to operate.

Direct more funding toward organic seed advocacy Organic seed policy organizing capacity is lacking in part because foundations and others in the philanthropic community don't fund the policy priorities described in this report – this is a risk point to the goal of establishing an organic food system built on a foundation of organic seed.

Introduction

In 2011, Organic Seed Alliance (OSA) published *State of Organic Seed*. This was the first comprehensive assessment of organic seed systems in the US. Following the publication of this benchmark study, OSA committed to updating this analysis with new data and recommendations every five years as a way to monitor the status of organic seed. We're proud to release this first five-year update.

The purpose of OSA's *State of Organic Seed* project is to measure the progress we're making in increasing the availability, quality, and integrity of organic seed. We envision an organic food system built on a foundation of organic seed. This report serves as an important summary of ongoing needs to achieve this goal and updated recommendations to guide future research, education, and policy efforts. As such, six objectives guide this project (see below).

State of Organic Seed project objectives

(1) Improve organic seed stakeholders' understanding of the barriers and opportunities in building organic seed systems (stakeholders include organic farmers, certifiers, seed industry, food industry, policy advocates, researchers, and others); (2) build regional seed networks that support a national supply chain of organic seed; (3) help organic farmers meet the National Organic Program (NOP) requirement to use certified organic seed; (4) support regulatory approaches that protect organic seed from contamination by excluded methods (e.g., GMOs) and prohibited substances without unintentionally damaging the nascent organic seed industry; (5) improve how seed is managed, both privately and publicly, to reduce concentration of ownership and stimulate competition and innovation, including addressing problematic intellectual property rights associated with seed; and (6) identify urgent organic seed research needs and increase investments to fund these and other priorities to improve organic seed availability, quality, and integrity.

History, vision, and principles of organic seed systems

As a fundamental input in agriculture, seed serves as a farmer's first defense against pest, disease, and other production challenges. Seed genetics also largely dictate the quality and integrity of our food – from appearance to flavor to nutritional content. But seed is much more than an input. It's a living, natural resource that demands careful management. Conserving and expanding seed diversity is paramount to ensuring a secure and healthy food supply.

Seed labeled as "organic" has a relatively short history. Organic seed must be grown under all of the requirements for organic food production. For example, organic seed crops are grown without substances prohibited for organic production, such as synthetic pesticides and fertilizers. The US Department of Agriculture's (USDA) National Organic Program (NOP) requires that organic operations be certified by an accredited certifying agent (ACA) and managed according to an organic system plan that is approved by this certifier.

When the NOP was launched in 2002, only a handful of companies sold certified organic seed. While the regulations require the use of certified organic seed to ensure organic integrity along the entire production chain, there remains an allowance for untreated, conventional (non-organic) seed when an equivalent organic variety is commercially unavailable. This exemption is necessary until the supply of organic seed can fully meet demand.

And demand is growing. Sales of organic products totaled more than $43 billion in 2015, an 11% increase compared to 2014. Food purchases represent $39.7 billion of this total.[1] Yet the organic seed supply isn't keeping up with this growth. As this report shows, most organic farmers still rely on conventionally produced seed for at least part of their operation.

There has been considerable progress in increasing the availability of organic seed. Critical investments in organic seed research are increasing. Dozens of companies now supply organic seed in the commercial mar-

ketplace. And our own data shows that farmers are using more organic seed.

Make no mistake: The benefits of expanding organic seed systems go well beyond helping organic farmers meet a regulatory requirement. Organic seed systems that respond to farmers' needs and adhere to the founding principles of the organic movement are paramount to the success and health of agriculture.

The challenges we're trying to address more broadly in agriculture include the preservation of crop genetic diversity and agricultural biodiversity; privatization of seed and market consolidation; agricultural production fueled by high-input, chemical systems that are toxic to humans and nature; genetic vulnerability in the seed and crops grown; nutritional deficiencies in the food supply; and social and economic injustices faced by farmers, plant breeders, food system workers, and the communities they feed.

The dominant seed system is driven by the profit motives of chemical and biotechnology companies. These players aggressively leverage intellectual property rights to the point of abuse. They discourage farmers from participating in research and seed saving. And too often they put shareholder interests before those of the greater public.

The organic community has an opportunity to create a much different path for organic seed. Our vision is to create organic seed systems very distinct from the dominant system. By establishing a shared vision and roadmap for developing organic seed systems, we can avoid the negative trends seen in the conventional seed sector while delivering high-quality organic seed for all scales, crop types, and regions. Seed is too important to be locked under patent rights and managed in the hands of a few corporations.

What do we mean exactly by an "organic seed system?" OSA envisions a seed system that takes a decentralized approach to breeding, production, and distribution, and where seed is managed as a public resource while allowing for healthy growth in the private sector. To foster such a system, actions must focus on increasing the diversity of genetic and financial resources, and expanding partners involved in breeding, seed production, and policy advocacy. Both competition and coordination are healthy factors in organic seed systems, but the benefits must be shared and the outcomes must support a thriving, environmentally sound agricultural system.

To do this, we must first understand the principles that guide this work and the benefits of establishing viable and resilient organic seed systems. The principles published in our first *State of Organic Seed* report continue to guide this project (see sidebar). In many ways they can be boiled down to the principles of health, ecology, fairness, and care – the same principles that built the organic movement.

The benefits of establishing organic seed systems are many. First, plants bred under organic conditions have the potential to be better adapted to these production systems. Organic farming challenges can be quite different from conventional systems, where synthetic chemicals and nutrient sources are commonly used to control pests, diseases, and plant nutrition. Seed provides the genetic tools to confront these day-to-day challenges in the field, and breeding plants in the environment of their intended use benefits this process.

Furthermore, adaptation is key to achieving resilience in our food and agricultural system. Adapting seed to changing climates, resource availability, and environmental conditions is one way to mitigate risks for farmers and the food supply they serve. This resiliency is longer lasting when more organic farmers have the skills to further adapt and improve plant genetics through seed saving and on-farm breeding.

Seed therefore represents profound potential for improving our food and agricultural systems. The plant genetics contained within a seed can determine if chemical controls will be necessary for dealing with production challenges (we can adapt seed to naturally resist disease). Genetics can also determine the security of our food supply (we can adapt seed to warmer and dryer conditions), how input-dependent crops are (we can breed for increased nutrient and water use

Principles guiding the State of Organic Seed project

1. Seed, as a limited natural resource, must be managed in a way that enhances its long-term viability and integrity.
2. The maintenance and improvement of genetic and biological diversity are essential for the success of sustainable food systems and greater global food supply.
3. The equitable exchange of plant genetics enhances innovation and curtails the negative impacts of concentrated ownership and consolidated power in decision making.
4. Sharing information enhances research and leads to better adaptation of best practices.
5. Agricultural research should serve more than one goal and strive to increase benefits for all living systems, including soil, plants, animals, and humans.
6. Public institutions and public employees should serve public needs.
7. Farmers have inherent rights as agricultural stewards, including the ability to save, own, and sell seed, and are key leaders in developing best practices, applicable research, and agricultural regulations and policy that affect them and the future of seed.
8. Application of the precautionary principle – the social responsibility to protect food systems from harm when scientific investigation has found potential risk – is necessary to create food security for the future.

efficiency), and the quality of our food (we can breed for improved nutritional content). Re-establishing a more resilient food system in the face of climate change requires a whole-systems approach based on proactive solutions. Seed is critical to resiliency and to this whole-systems approach. A "systems breeding" approach can provide the agricultural, environmental, social, and economic qualities that reflect the values of organic agriculture.

Organic seed systems also benefit our environment. Agriculture brings the interconnectedness of natural systems and human activity into sharp relief. The way we farm has a huge impact on our environment and human health. Agriculture burns significant amounts of fossil fuel and emits other greenhouse gases into the atmosphere. Most American agriculture relies intensively on synthetic chemicals, including modern pesticides that are almost entirely produced from crude petroleum or natural gas products.

Conventional seed is typically produced in chemical-intensive systems (see sidebar). Not many farmers, let alone consumers, think about their "seed footprint" – that there are negative byproducts to consider even before a seed is planted. Crops grown for direct consumption, such as vegetables, are typically harvested before they go to seed. Crops grown for seed remain in the ground longer to complete their reproductive cycle. This extended growth means there are more opportunities for pests and diseases to damage seed crops. Pesticide regulations often allow higher applications of chemicals on non-edible crops, including crops produced for seed. There are also chemicals used in seed production to enhance pollination and ensure that the seed doesn't shatter prior to harvest. Therefore, when farmers choose organic seed they're choosing to not contribute to this upstream pollution caused by conventional seed production.

Third, expanding organic seed systems can increase economic opportunities for farmers who successfully integrate seed production into their operations. The economic benefits include selling seed commercially, becoming more seed self-sufficient and reducing input

Pesticides used in cabbage seed production

Below is a list of typical pesticide applications – including herbicides, insecticides, and fungicides – for conventional cabbage seed production in Washington, a state that represents approximately 75% of cabbage seed production in the US and 25% of cabbage seed production in the world.[2] Each year, 400-500 acres of cabbage seed is grown in the state. Recommendations for pesticide applications may vary, and in some cases will be higher than those listed below when multiple pesticides are applied in combination. The absence of toxins, including synthetic pesticides, in organic production is one of the many benefits to expanding organic seed acreage.

Herbicides:

100% of acreage receives a pre-plant herbicide application
50% of acreage receives a herbicide application in late fall or spring
35% of acreage receives an herbicide application in late spring pre-bloom

Insecticides:

100% of acreage is treated with an insecticide at transplanting
100% of acreage is treated with a second insecticide after transplanting
100% of acreage is sprayed with insecticide at bloom (timed to avoid bee activity)

Fungicides:

100% of seed planted for cabbage seed production is treated with a fungicide
50% of acreage receives a fungicide application in late winter-spring
100% of acreage receives multiple fungicide applications from full bloom to pre-harvest

Seed is too important to be locked under patent rights and managed in the hands of a few corporations

costs, and limiting financial risks by having seed that is better adapted to individual farms.

And, fourth, the expansion of organic seed systems has been coupled by a growing diversity of stakeholders involved in their development. For example, more chefs, retailers, and food companies are involved in variety tastings and evaluations, identifying market gaps, and even in organic breeding projects. This diversity of decision makers fosters a more participatory and decentralized approach to seed innovation. This approach facilitates market adoption of new varieties with aesthetic and culinary qualities demanded by organic consumers while also addressing the agronomic challenges related to organic production.

State of Organic Seed methods: Hearing from stakeholders

An organic seed system, like all seed systems, involves the essential practices of breeding, production, and distribution to deliver the end product. The quantity and quality of organic seed delivered to farmers is the result of various stakeholders and their actions within this system. Stakeholders include plant breeders and other agricultural researchers, organic certifiers, seed companies, policy advocates, organic food processors, retail businesses, and the farms planting organic seed, to name just some. Actions include research, education, policy, and advocacy efforts. No single stakeholder group can address the diverse seed needs of organic farmers alone. When actions are guided by shared values, the progress is faster, more coordinated, and longer lasting.

Organic seed systems are therefore the product of multi-stakeholder efforts. Any system – any movement – is only as strong as the sum of its parts. To that end, methods for developing our report findings and recommendations required diverse stakeholder input. To understand the challenges and solutions before us, we needed useful data from these stakeholders. We conducted formal surveys with several of these stakeholder groups and held eight listening sessions to gather additional input from community members not targeted by surveys. Our methods for data collection are further described in the appendices.

Farmer survey

In 2014, we conducted a national survey of certified organic crop growers to assess their attitudes and perceptions regarding organic seed, their current use of organic seed, and any obstacles that restrict organic seed sourcing. The survey also asked which crops and traits should be prioritized through organic plant breeding programs. Many additional topics were covered in this survey. We conducted a survey in 2009 that asked many of the same questions, allowing us (for the first time) to measure our progress over the last five years.

Certifier survey

Most major accredited certifying agencies (ACAs) responded to our organic certifier survey. Collectively these 22 ACAs represent 68% of certified operations in the US. This survey, distributed in 2015, helped us understand how the organic seed requirement is being enforced, challenges ACAs face in enforcement, and their ideas for how to make enforcement more consistent.

Seed company survey

In 2015, we conducted a survey of seed companies that produce and supply organic seed. The purpose was to better assess the challenges and opportunities in growing the organic seed industry. We heard from 16 companies that range in size and scale.

Researcher survey

Our analysis of organic seed research investments allowed us to identify the primary sources of funding

and what these resources contributed to in the way of topics, crops, and regions. We conducted the same analysis five years ago, so our findings in this report represent our first update to those data. We also distributed a survey to the principal investigators of each research project that fit the categories of organic plant breeding and other organic seed research. We asked open-ended questions that helped us better understand the successes, challenges, and opportunities for organic seed research.

Listening sessions

Lastly, we held eight listening sessions at organic farming conferences in 2014 and 2015. These listening sessions were important for gathering additional input through guided discussions with stakeholders representing different geographies, including individuals not targeted by the surveys described above, such as organic seed producers, food companies, and policy advocates.

This report is organized by three chapters that each covers the distinct components of an organic seed system. We conclude the report with a summary of recommendations to serve as a roadmap for the organic community over the next five years.

> *The purpose of OSA's State of Organic Seed project is to measure the progress we're making in increasing the availability, quality, and integrity of organic seed*

Chapter 1 covers the burgeoning scientific field of organic plant breeding, where increased research investments are leading to more innovation in the public sector and on our nation's farms. We provide a short history of this field and updates on research investments in organic plant breeding and other organic seed research. We also provide examples of progress we've made since our 2011 report in expanding funding and partnerships. Lastly, we discuss major challenges to expanding organic plant breeding as a field and industry. In particular we take an in-depth look at the role restrictive intellectual property rights can play in inhibiting organic seed innovation.

Chapter 2 discusses the state of the organic seed supply – our community's capacity to commercially produce organic seed varieties in ample diversity, quality, and quantity. By looking at results from our national farmer survey, we're able to identify progress in farmers' access to and use of organic seed, as well as remaining barriers to increasing the amount of organic seed being used. Findings from our organic seed company survey helped us outline major challenges in increasing our organic seed production capacity, including ensuring growth in the organic seed industry. The organic seed community has made progress in training more organic seed producers here in the US, but increasing the number of skilled organic seed producers remains a major need.

Chapter 3 provides a number of updates on policy discussions and initiatives that support the growth and success of organic seed systems. These updates cover the work of the National Organic Program and the National Organic Standards Board as their efforts relate to consistent enforcement of the organic seed requirement and the issues of organic seed purity and excluded methods. Policy updates on GMOs include a discussion on the regulation of biotechnology. We also provide a short update on advocacy to increase public funding for classical plant breeding and public cultivar development for the organic community and beyond.

Chapter 1

State of Organic Plant Breeding

Organic plant breeding is now an established field in the public and private sectors. It's broadly accepted that organic systems provide different growing environments from conventional systems and that breeding crops under organic conditions can deliver varieties that increase the success of organic farmers and strengthen the organic integrity of their products. And yet most organic farmers still rely on plant varieties bred in and targeted for conventional systems.

Conventional production systems often rely on synthetic fertilizers and on toxic chemicals to combat pests and diseases. At its best, farming organically isn't just a matter of replacing these chemical inputs with others allowed by the organic standards. Organic agriculture embraces long-term and preventative strategies, such as building soil health and enhancing biodiversity, to address pest, disease, fertility, and other production needs. This low-input and systems-based approach also means organic farmers are more dependent than their conventional counterparts on plant varieties that have strong resistance to pests and diseases and are adapted to specific environmental conditions and farming practices. Yet conventional agriculture is receiving the bulk of research investments.

The origins of organic plant breeding in the US aren't well documented. In the 1970s, the private seed sector began to grow rapidly, in part because the Plant Variety Protection Act (PVPA) provided plant developers

temporary yet exclusive control over the marketing of new varieties. At this time, non-governmental organizations (NGOs) and a handful of seed businesses with an interest in supporting organic agriculture were also established. These players commonly lacked breeding programs and largely focused on conserving and selling open-pollinated and heirloom plant varieties to counter the loss of crop diversity that was emerging in the commercial seed sector.

In the 2000s, organic plant breeding and seed production gained more attention. The lack of seed appropriate for organic agriculture, coupled with the organic seed requirement established by the 2002 National Organic Program (NOP), provided urgency for this need. Furthermore, growth in the organic seed sector ushered in a growing awareness of the concept of breeding for organic systems. The organic community began to focus on advancing plant breeding in a way that met organic principles and provided more options for organic farmers and other growers underserved by the dominant seed companies.

Since the NOP was established, both the private and public breeding communities have responded to the demand for organic seed. We know the supply is growing because of an increase in organic seed companies since the NOP launched and an increase in their sales. We conducted a survey of organic seed companies to better understand changes over the last five years, finding that most of the companies responding experienced a gross revenue increase of 6 – 20+% over this time period from certified organic seed.*

Organic seed purchasing is up, but what do we know about our national infrastructure for organic plant breeding? A few seed companies have budgets for organic plant breeding, but most don't and instead rely on larger organic companies and university breeding programs to provide varieties appropriate for organic systems.** New players have entered the organic seed industry in the last ten years. These companies are generally regionally focused with an emphasis on conserving and expanding genetic diversity. Though they operate on a relatively small scale, some of these companies are contributing to the organic seed supply by breeding new varieties and improving older varieties, often in partnership with farmers. Some of these companies were launched in response to market concentration that resulted in farmers seeing important varieties disappear from their seed catalogs.

Because organic plant breeding is still in its infancy, relatively few varieties available today have actually been developed in organic systems. Both private and public breeding programs face challenges to increasing investments in organic breeding. Below we explore progress made as well as challenges and needs moving forward for both sectors.

Organic plant breeding in the private sector

As mentioned, over the last 20 years the seed industry in general has become much more concentrated – meaning plant-breeding decisions for many major crops are being made by a handful of companies. Mergers and acquisitions are justified for the purpose of efficiencies of scale. As a result, large geographical areas are abandoned and farmers in these areas are left to use old varieties or newer ones developed for other regions that may be less than ideal but still come closest to fitting their needs. Furthermore, the most dominant seed players are chemical and biotechnology companies with no genuine interest in the success of organic agriculture and therefore hold no interest in the continued supply of existing varieties that might serve organic farmers' needs. For these companies, new varieties must first excel in major production areas or across a wide range of environments. Organic producers working in more difficult or less common growing conditions, meanwhile, are left looking for varieties that just happen to meet their needs.

Seed companies of all sizes with an interest in organic plant breeding face a number of challenges to increasing investments in this area. These challenges are interrelated with other parts of an organic seed system, from production to policy. For example, companies re-

* This initial survey was the tip of the iceberg in understanding the needs of organic seed companies. For our 2021 report, we will be conducting a deeper survey that goes into specific crops, acreage, and economics, and the diversity and scale of organic seed companies, to collect more detailed data on seed industry growth.

** A few larger companies primarily focused on breeding have diversified into organics, including Enza Zaden/Vitalis Organic Seeds and Bejo Seeds. Medium-scale retail companies are also actively building organic plant breeding programs with significant investments, such as High Mowing Organic Seeds and Johnny's Selected Seeds. Smaller companies are actively breeding for organic agriculture as well, and though we can't name them all, some include Adaptive Seeds, Fruition Seeds, Prairie Road Organic Seeds, and Wild Garden Seeds.

sponding to our survey say that organic certifiers are too lenient in allowing conventional seed to be planted by organic growers. In one company's words, there is an "ongoing lack of regulatory enforcement and gaping holes in regulatory interpretation" of the organic seed requirement. If farmers don't buy organic seed, companies will lack the money and incentive to invest in organic plant breeding.

Another company said the burden and costs of testing breeding lines for GMOs, and having access to non-GMO lines, is a challenge to developing a robust organic seed supply. Finally, capital and infrastructure constraints were mentioned by a number of companies. All of these challenges are described in more detail in Chapter 2.

The seed industry alone cannot address all of the seed needs of organic farmers. Diversity at multiple levels leads to a more sustainable agriculture: genetic diversity, crop diversity, farm diversity, funding diversity, and intellectual diversity, to name a few. A diversity of stakeholders and decision makers, especially at the plant-breeding level, is essential, because plant-breeding decisions help determine the future of our food supply. These decisions should be the responsibility of many decision makers in both the public and private sectors.

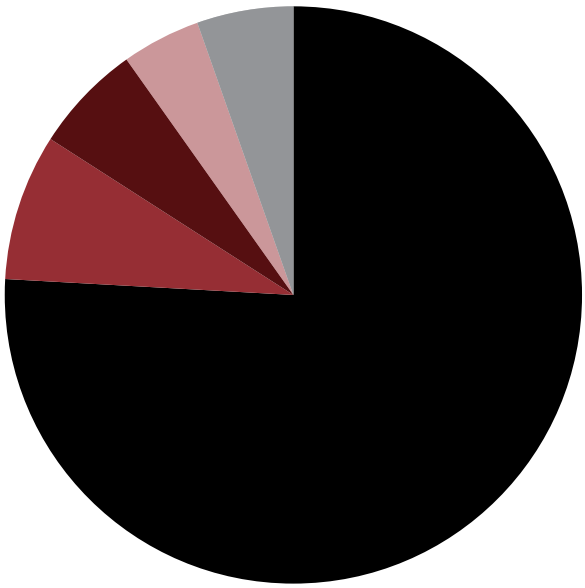
As you'll read below, we have good data on organic plant breeding funding directed toward the public sector. However, we lack that kind of data for the private sector. It will be helpful in future analyses if we can estimate the level of private investment in organic breeding.

Organic plant breeding in the public sector

Public and NGO plant breeding programs are critical to developing healthy organic seed systems. Ideally, public breeders shouldn't overly rely on the direct economic benefits resulting from their programs and instead operate with more independence.* This independence allows public programs to focus on developing varieties that meet the regional needs of the organic farming community and not on varieties that are widely adapted (coast-to-coast) or that meet the criteria of investors. This independence also fosters another important function of university breeding programs: to train the next generation of plant breeders.

In the public sector, federal grants that support organic research have helped to formalize organic plant breed-

Figure 1. Funding for public organic plant breeding and other organic seed initiatives by source (1996 - 2018)

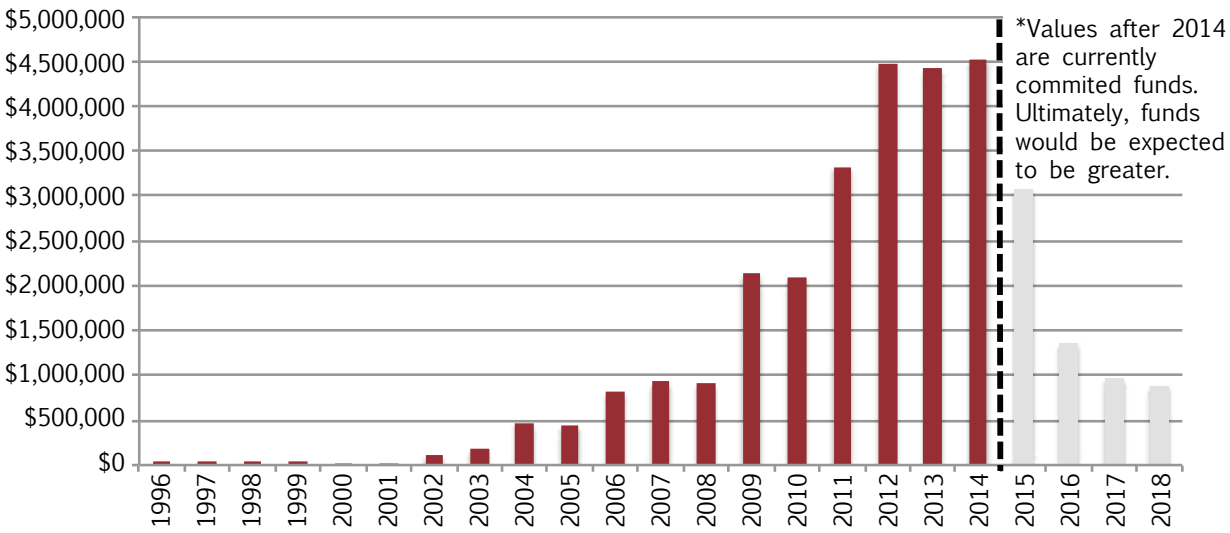


OREI	$23,739,767
SARE	$2,565,410
Other Federal Funds**	$1,909,248
Clif Bar Family Foundation	$1,382,420
Other Non-Federal Funds***	$1,688,961

** Including RMA, RBEG, SCBG, Hatch, and others
*** Including FAFO, CERES Trust, OFRF and others

* It's important to note that if public plant breeders or their programs do not receive compensation from variety releases it becomes even more important that public funding is used to encourage them to work on breeding projects that are a priority for organic agriculture. Breeders are at least in part driven by economics. There is an important balance between the economic incentive to seek grants, private investments in plant breeding, and economic benefits from variety releases. If a breeder is overly driven by economic returns then there is less incentive to breed for lower value crops or varieties.

Figure 2. Funding for public organic plant breeding and other organic seed initiatives by year



ing within university and NGO programs (see Figure 1). In particular, the USDA's Integrated Organic Program, which later became the Organic Research and Extension Initiative (OREI), and the Sustainable Agriculture Research and Education (SARE) program, have provided support over the years for organic breeding. Other federal programs and non-profit and private foundations have also invested in public organic breeding and seed research.

Funding the next generation of organic plant breeders

The Clif Bar Family Foundation is helping to fill important gaps at our land grant universities by funding the first organic plant breeding fellowships in the US. A total of 14 Ph.D. fellowships have been funded at Cornell University, North Carolina State University, Oregon State University, Texas Tech, University of California-Davis, University of Wisconsin-Madison, and Washington State University. Research goals include improving the quality and yield of organic crops, including barley, wheat, quinoa, oats, broccoli, squash, cotton, cover crops, green beans, field corn, and sweet corn.

According to our analysis, federal and state agencies and private foundations have contributed more than $31 million to organic plant breeding and other organic seed initiatives since 1996 (see Figure 2). The vast majority of this funding (88%) has supported organic plant breeding and variety trials.* Other areas include seed production research and education, enterprise development, systems development, and policy (see Figure 3).

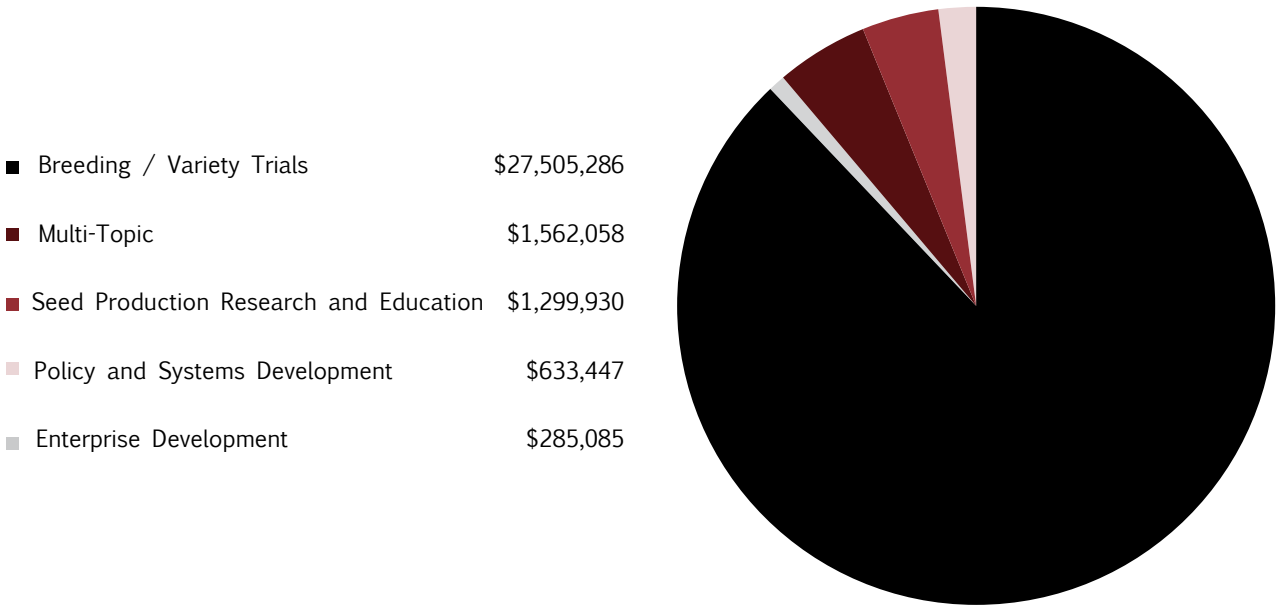
Investments have increased rapidly. Of the $31 million, more than $22 million has been contributed in the last five years alone. The largest three sources of funding were USDA-OREI, SARE, and other federal funding programs.** Since our 2011 analysis, a major new funder of organic seed research has joined the list. The Clif Bar Family Foundation is currently the fourth largest supporter of organic plant breeding and other organic seed initiatives, representing more than $1.3 million of these investments.

By region, projects receiving the most support include those labeled as "multi-regional," followed by those in the Pacific Northwest, Midwest, and Northeast (see Figure 4). In our 2011 analysis, multi-regional projects re-

* Some of these organic plant breeding and variety trial projects also included aspects of seed production research and education, but those aspects were too small to be considered major parts of the projects.

** Other federal funding sources include USDA's Risk Management Agency, Rural Business Development Grants, Specialty Crop Block Grants, Hatch funds, and other sources.

Figure 3. Funding for public organic plant breeding and other organic seed initiatives by topic (1996 - 2018)



ceived the lowest amount of funding – a notable change. The difference represents nearly a 13-fold increase in funding for multi-regional projects, demonstrating growing interest in collaborative, multi-state projects.

By crop type, vegetable projects received a large increase in funding, receiving more than three times that of most other crops (see Figure 5). Wheat received the most funding in our last analysis, yet over the last five years, that crop has seen only a modest increase in funding. Other large increases were seen in corn, small grains, and legumes.

Clearly, investments in organic seed research have increased markedly since our 2011 report, but what are the results of these investments? We conducted a survey of the principal investigators for organic seed research projects identified in our analysis. We asked these researchers questions that help us understand project successes, challenges, and opportunities for future organic seed research. We also gathered information about whether other stakeholders were involved and if new projects emerged from these investments. (See Appendix A.3 for a list of the survey questions.)

A total of 46 researchers responded to our survey. As already mentioned, most of their projects were focused on organic plant breeding and variety trials. This may be in part due to farmer demand, as one researcher noted: "[Farmers] want to do variety trials, so this is what we do with them!" Research projects involving major crops (small grains and field corn) focused exclusively on breeding and trials whereas projects associated with multiple vegetable crops included the widest range of project types, such as seed production research, education, or systems development.

Reported successes

Researchers reported a variety of findings. One of the primary successes was the development or identification of germplasm, breeding lines, or populations. This indicates that these research programs are gaining momentum in developing varieties for organic production systems. Several researchers reported that new varieties would be released in the near future, and nearly 30% of respondents indicated that research projects contributed to the release of a finished variety.*

* The reported success of 30% of projects contributing to the release of finished varieties shows improvement when compared to our 2011 report, where we reported "few projects produced finished varieties."

Releasing finished organic varieties is an important outcome of these investments. Finished varieties also provided earned revenue for some research projects. We asked what, if any, intellectual property tools were used to release finished varieties. Researchers reported using license agreements, Plant Variety Protection certificates, and Open Source Seed Initiative pledges. In other cases, researchers didn't release the varieties under any formal protection.

Researchers reported that 15% of the projects received some amount of earned revenue. This revenue came from royalties on released varieties, seed sales, and produce sales generated during trials and breeding. These forms of revenue have the potential to provide base level support for ongoing research. Several researchers indicated they were exploring the potential for earned revenue from future variety releases.

Figure 4. Funding for public organic plant breeding and other organic seed initiatives by region (1996 - 2018)

REGION	FUNDING AMOUNT
Multi-region	$11,761,868
Pacific Northwest	$5,081,970
Midwest	$4,374,631
Northeast	$4,367,395
Southeast	$3,033,142
Southern Plains	$1,700,661
Northern Plains	$616,828

Figure 5. Funding for public organic plant breeding and other organic seed initiatives by crop (1996 - 2018)

CROP	FUNDING AMOUNT
Vegetables	$10,506,306
Multiple	$3,727,097
Corn	$3,636,864
Multiple small grains	$3,601,476
Other	$3,159,451
Wheat	$2,754,533
Legumes	$1,724,706
Multiple field crops	$1,192,854
Potato	$982,519

* Organic Farming Research Foundation tracks organic programs in the US land grant university system. Its most recent assessment shows the number of land grant universities offering organic academic programs grew from zero to eight between 2003 and 2011. (Find the 2012 Organic Land Grant Assessment at www.ofrf.org)

Training graduate and undergraduate students is another success reported in nearly 30% of projects. As one researcher described: "The long-term impact of this important educational element is to establish the next generation of researchers, extension, and industry representatives with organic systems expertise." Additionally, organic research was described as an important recruitment tool for attracting new students. Though the number is still small, more universities are offering organic research programs in response to interest among students.*

Reported challenges

Researchers reported several challenges with their projects. These challenges include time and staff capacity, insufficient funding, access to appropriate field locations, lack of expertise, and legal challenges associated with intellectual property.

The primary challenge reported was time and staff capacity. This wasn't necessarily associated with insufficient funding, though funding issues were still noted. Researchers reported needing longer-term funding to support staff and infrastructure for their plant breeding programs. As one researcher said: "Without a strong

The next generation of organic plant breeders get organized

There is a new wave of graduate students studying organic plant breeding and seed systems. In 2012, some of these students organized the first Student Organic Seed Symposium (SOSS) with the purpose of bringing together other students from multiple universities who held the same interest, in addition to public and private breeders, policy advocates, and seed industry representatives. SOSS is now an annual event that continues to bring together a strong group of organic seed students and professionals to support the still nascent scientific field and industry. SOSS recently expanded their scope from an annual symposium to create a more formal society with the goal of providing greater networking and professional development opportunities for current students and post-graduates beginning their careers.

core of essentially 'permanent' support, a breeding program's size is inherently constrained."

Access to appropriate testing locations was also reported as a challenge by more than a quarter of respondents. This challenge included the availability and quality of organic research sites as well as locations with appropriate pest pressures. Producing enough seed was a challenge for breeding and variety trialing projects, indicating a need for access to more locations for organic seed production. The lack of specific expertise included data analysis and trial design as well as crop-specific knowledge within a region or institution.

Finally, restricted access to germplasm due to intellectual property rights was reported as a legal challenge. One researcher described the issue this way: "Restrictive licenses for germplasm, bag tags that specified no breeding or seed saving and the like, were obstacles in using some of the … cultivars we wished to use." As we will explain later in this report, intellectual property rights remain a barrier to organic seed innovation.

Reported opportunities

Some opportunities identified by researchers include more basic research directed toward organic production, including developing molecular markers for disease resistance and investigating traits important to organic systems, such as weed competitiveness. Other needs identified by researchers include: addressing seed-borne diseases, expanding organic land on university research farms, finding new avenues for commercializing varieties, and disseminating variety trial results. There's strong potential for continued research as 65% of respondents said their work had contributed to new projects.

Reported stakeholders

Researchers reported strong stakeholder involvement. Nearly 90% of respondents reported that other stakeholders were involved in their research, including farmers (72%), public sector and non-profit researchers (33%), end-users (13%), and seed companies (13%).* These stakeholders played a variety of roles, from identifying the needs and objectives of the project to fully participating in the development, execution, and analysis of projects. Farmer involvement was primarily seen in trials, and their involvement was described as critical. One researcher said this about farmer involvement: "We could not do this project without their involvement. Helpful is not a strong enough word. They are required partners." Another researcher said that projects that empower farmers are important for promoting the development of varieties outside the restrictive framework of university-led projects.

In farmer-led and collaborative projects, academic and non-profit researchers contributed expertise on specific crop, pest, or methodology (15%) and assisted in project design (13%). End-users were primarily engaged in evaluation (11%) as well as defining objectives (7%). Seed companies played a role in multiple aspects.

Current investments

It's encouraging to see increased funding in federal programs like OREI, especially since this program has been the biggest contributor to public organic breeding initiatives. But it's important to note how these investments compare to current funding for non-organic seed research (see Figure 18 in Chapter 3).

Furthermore, breeding programs that overly rely on one federal grant program are in a vulnerable position. To illustrate, OREI was created in the 2002 Farm Bill to fund research, education, and extension projects that enhance the ability of organic producers and processors to grow and market high-quality organic agricultural products. The program was reauthorized with mandatory funding in the 2008 Farm Bill. Due to infighting, Congress was unable to pass the next Farm Bill on time, and OREI's authorization and funding expired on September 30, 2012. OREI became one of several "stranded" programs caused by the delay in passing what's now the 2014 Farm Bill. Congress eventually reauthorized the program and provided $20 million annually for five years in mandatory OREI funding. Still, the research community lost an entire year of funding in 2013, and the situation created uncertainty for many organic breeding programs.

* By "end-users" we mean processors, such as bakers, millers, maltsters, consumers, and food companies.

This is just one reason why the organic community needs more diverse funding sources for organic seed research (see page 23). Another important reason is demand. Most of the funded OREI proposals are related to organic breeding projects. Other federal programs are also unable to meet demand. For example, the Agriculture and Food Research Initiative (AFRI), the largest federal program funding plant breeding, received more than 170 proposals for plant breeding related projects in 2014. There were only enough funds to grant six awards.[3] In addition to these breeding projects, two conference grants were awarded to identify organic plant-breeding priorities by region: one in the Northeast and the other in the Pacific Northwest. These conference grants represent some of the only AFRI funding in history directed toward organic agriculture.

Fortunately we're making some progress in increasing public plant breeding investments by program area. For example, in December 2015, Congress passed a final budget deal that included an extra $2 million toward SARE, bringing the funding to $24.7 million, the highest level of funding since the program was created in 1988. SARE was originally passed with the recommendation that it be funded at $60 million. Clearly we have a long way to go to ensure that this critical grant program is funded at its intended amount. SARE grants fill an important niche for smaller scale research, including breeding and seed work that's largely farmer-driven, whereas AFRI, OREI, and Clif Bar Family Foundation investments typically fund projects with much larger budgets.

The December 2015 budget bill also included a significant increase of $25 million for AFRI. This is great news, to be sure, yet an ongoing challenge with AFRI grants is how these funds are allocated, which largely depends on who serves on the grant review committees. We've seen more AFRI plant breeding dollars directed toward genomics and other lab-based methods at the great expense of field-based breeding. As explained in Chapter 3, urging the USDA to prioritize classical breeding projects and public cultivar development remains an essential component of organic seed advocacy.

Because some seed companies are reluctant to enter, or increase investments in, organic plant breeding, funding for public organic seed research provides university and NGO plant breeders an important opportunity to research crops that may otherwise be the domain of the private sector. These investments are also training the next generation of plant breeders. Furthermore, public plant breeders report that organic research programs, such as USDA-OREI, provide some of the only funding for classical plant breeding projects where the end goal is improved varieties adapted to specific environmental conditions and climates.*

> *More than 70% of the organic seed research projects conducted over the last five years involved farmers. One researcher shared, 'We could not do this project without [farmer] involvement. Helpful is not a strong enough word. They are required partners.'*

Growing interest in organic agriculture is a positive trend in what otherwise are troubling changes within our university breeding programs. These programs continue to play a critical role in agricultural innovation, yet they're at risk of extinction. One survey shows that the number of university plant breeders has fallen more than 30% in the last 20 years.[4] Another survey shows that as these breeders retire, there aren't enough younger breeders in the system to maintain their programs. Of 192 public plant breeders releasing finished cultivars, 55% have been working for 21 years or more.[5] As these breeders retire, there aren't enough younger breeders currently in the system to maintain this level of cultivar development. When asked if their institution will continue their cultivar development work after they retire or otherwise leave their position, more than half of the breeders responding to the survey weren't confident their position would continue.

This trend has dire consequences for our seed supply and broader food system. Publicly funded breeders have more freedom than their private counterparts to address critical – yet potentially less lucrative – research that benefits smaller markets, such as organic agriculture and minor crops.

* This sentiment has been expressed by a number of public breeders in response to funding priorities established by other agricultural research programs, including AFRI, where the majority of funding has gone toward genomics and lab-based methods and not toward field-based breeding. There are other pools of funding that breeders are tapping into for classical breeding projects, including commodity funding that helps support variety development in crops like sorghum, soybeans, and potatoes.

More organic food companies are investing in organic seed

Since our last report, we've seen more interest and investment from organic food companies – from processors to distributors to retail. Take Organically Grown Company (OGC), the largest organic produce distributor in the Pacific Northwest. OGC approached Organic Seed Alliance's research team about organically breeding varieties of purple sprouting broccoli. The project quickly took off thanks to their support. The project goal is to provide Pacific Northwest growers with regionally adapted organic seed for winter food production, as the broccoli is harvested at a time when little diversity in fresh produce is available. The project has now grown to include researchers at Oregon State University and Washington State University, and has attracted additional funding from two state specialty crop block grant programs. Chefs and other stakeholders are also participating in variety tastings to inform breeding decisions. Currently, there are few organic and open-pollinated purple sprouting broccoli varieties in the marketplace. Soon growers will have several varieties to choose from – all organically bred.

Also in the Pacific Northwest, the Port Townsend Food Co-op, recognizing the challenge of growing sweet corn in the region's relatively cool climate, is partly funding a breeding project to adapt 'Who Gets Kissed?' organic sweet corn to the Olympic Peninsula. Collaborators include the University of Wisconsin-Madison breeders who developed 'Who Gets Kissed?' and other breeding lines as well as the Northern Organic Vegetable Improvement Collaborative (NOVIC). The goal is to create an early maturing, open-pollinated organic sweet corn variety that thrives in the maritime climate. Collaborators aim to release varieties to the marketplace in the next few years.

In 2015, Lundberg Family Farm, known in the marketplace for their organic rice products, contributed funds to support two graduate students in organic quinoa breeding. Washington State University's Agricultural Research Center provided a generous match to the Lundberg graduate fellowships. One of the fellows tested various quinoa varieties for agronomic characteristics and yield in partnership with organic farms in western Washington. This research also included a focus on weed control in organic quinoa production using transplants and geese as potentially beneficial tools for organic quinoa farmers. The second fellow worked with organic farmers in Idaho, Oregon, and Washington on variety trials, comparing the effect of natural selection versus farmer-assisted selection. This fellow is also looking at the association between quinoa roots and microbial communities in the soil to identify potential benefits derived from variety-specific mycorrhizal associations.

Also in 2015, Clif Bar & Company and Organic Valley established the nation's first endowed chair focused on organic plant breeding. The recipient was the University of Wisconsin-Madison, and the endowment will be funded in perpetuity with a $1 million gift from the companies and a $1 million match from a UW alumni couple. Clif Bar & Company has committed to funding four additional endowed chairs by 2020.

The Seeds & Breeds for 21st Century Agriculture coalition held a summit in 2014 to discuss the state of our seed supply and develop recommendations for re-building our public breeding infrastructure.* Summit participants and the resulting proceedings identified challenges that contributed to the decline of public seed available to farmers, including shrinking public funding for classical breeding, fewer public plant breeders, intellectual property restrictions, and aging public seed collections, to name a few. All of these challenges have affected our public plant breeding infrastructure broadly, and organic plant breeding specifically. Many programs are interested in addressing the needs of organic agriculture but are losing the capacity to do so.

As public funding of university programs steadily decreased over the years, industry-funded research at universities increased. For example, the contributions of just three corporations – Monsanto, Cotton Inc., and Pioneer Hi-Bred – to the Texas A&M Department of Soil and Crop Sciences made up 56% of the department's research grants between 2006 and 2010.[6] Private donations now provide nearly a quarter of the funding for agricultural research at land grant universities.[7]

Industry funding for public research may not be something to criticize on its own, especially with diminished public funding, but private investments can come with strings attached, such as having the power to dictate whether research findings are kept private or published.[8] There's also no doubt that university research has become increasingly privatized over the last quarter-century. The shift in US policy toward stronger rights for intellectual property owners fostered the privatization of public research, as did the 1980 Bayh-Dole Act, which encourages universities to patent and license public research as opposed to placing that research in the public domain. Prior to Bayh-Dole, most universities were reluctant to patent and license their research for fear of compromising their commitment to "open science" and their institutional mission to broadly disseminate knowledge. Between 1980 and 1990, the number of patents awarded to universities jumped from 300 a year to more than 3,000.[9] Universities now earn almost $2 billion annually from licensing research.[10]

These figures are used to boast the success of Bayh-Dole and to claim that the law was necessary for improving technology transfer of publicly funded research. But numbers demonstrating increased patenting and licensing of university research and increased income don't necessarily mean more outputs are being transferred, that the public good is being served, or that profits are coming back to research and development programs. In fact, evidence has emerged that challenge these supposed benefits.**

Intellectual property rights are a barrier to seed innovation. In both the public and private breeding sectors, intellectual property rights inhibit breeders' and farmers' freedom to operate. As explained in Chapter 3, increased privatization of seed has devastating consequences and the problem needs to be addressed.

Participatory plant breeding

The growth in organic plant breeding has paralleled growth in participatory approaches to breeding in the US and Europe. These approaches are documented in a growing body of scientific literature and extension resources on the topic. According to our survey of researchers described above, farmers play a number of roles in research projects, from developing projects and methods to evaluating findings.

Participatory plant breeding (PPB) is an approach where farmers collaborate with formal breeders on breeding and variety evaluation. At times other stakeholders are involved, such as seed companies, food processors, retail food companies, and chefs. In this model, organic farmers work in partnership with university, USDA's Agriculture Research Service, non-profit, and private industry plant breeders to improve seed for organic farms. Participatory breeding empowers farmers to take a lead role in developing new seed varieties by combining their practical experience with the technical expertise of formal plant breeders. In fact, several requests for proposals from USDA and non-profits that fund plant breeding – including the Agriculture and Food Research Initiative (AFRI), Organic Research and Extension Initiative (OREI), and the Organic Farming Research Foundation

* For more information about the 2014 Seeds & Breeds for 21st Century Agriculture Summit, including the full proceedings, visit www.rafiusa.org.

** The Brookings Institution concluded that, in any given year, the revenue funneled into university budgets from patents and licensing deals is not enough to cover the cost of running most technology transfer office (see "University Start-Ups: Critical for Improving Technology Transfer" http://www.brookings.edu).

(OFRF) – now encourage proposals that include participatory plant breeding methods, incentivizing researchers and farmers to embrace this collaborative model. This decentralized model of breeding is resulting in varieties that meet the needs of local producers and consumers, and more farmers gaining skills to develop their own varieties (see sidebar).

Most of the researchers who responded to our survey use participatory methods. The significant interest in applying participatory models to organic plant breeding may be attributed to several factors. The organic seed industry is still nascent and while a few larger companies have entered the market and mid-size companies are professionalizing their operations, there are still many companies that rely on seed producers to collaborate on variety improvement and maintenance. For this reason, many organic seed producers are accustomed to engaging in field selection and crop evaluation. Furthermore, smaller, diversified organic seed companies often lack hybrid breeding programs and rely on open-pollinated varieties that lend themselves more readily to on-farm plant breeding and variety improvement.

Organic producers are also required to use organic seed when available, so many are motivated to support the development of varieties appropriate for their system. From our farmer survey, further described in Chapter 2, most respondents indicate that they want their organic seed purchases to encourage organic breeding and they believe breeding for organic systems is important to the overall success of organic agriculture. About a quarter of farmers who responded said they're interested in on-farm plant breeding regardless of whether there is economic opportunity.

Farmer-initiated organic breeding projects that are not funded by public or private programs aren't captured in this report. However, it's important to note that dozens of farmer-bred varieties are currently offered in organic seed catalogs. An analysis of these contributions to organic seed availability will be worth considering for the next *State of Organic Seed* report, slated for 2021.

As mentioned, more than 70% of the researchers responding to our survey reported farmer engagement. Farmers hosted research trials or breeding projects in 50% of the projects. However, only 30% of the researchers reported that farmers were involved in the evaluation of projects – a reminder that most organic seed research is researcher-driven.

Participatory plant breeding offers formal plant breeders the potential to conduct breeding in realistic on-farm conditions and to learn from the expertise of farmers. Organic farms provide necessary access to real, working organic systems for testing and variety development, and on-farm selection may increase adaptation to local organic farming conditions. However, as noted earlier, more than a quarter of the researchers reported that they lacked access to certified organic land and that this was a barrier to the success of their work. Compared to conventional systems, organic farming systems may have more variable environments both within and across farm sites, including more variable pest and disease pressures, microclimates, soil conditions, and nutrient availability. With these variable environments, farmer involvement helps lead to more successful field evaluations, as the farmers may have a better ability to identify individual plants in their fields that are thriving due to their genetics rather than due to the chance of being planted in a better field site on the farm.

Participatory breeding gets results

Participatory research has already resulted in a number of new organic varieties now available in the marketplace. One example includes 'Solstice' broccoli, an open-pollinated variety released in 2012 and developed through a participatory plant breeding project involving Jonathan Spero of Lupine Knoll farm in Oregon and Jim Myers of Oregon State University. A second example is 'Who Gets Kissed?' sweet corn, an open-pollinated and organically bred variety that was commercially released in 2014. University of Wisconsin-Madison breeders worked with Martin Diffley of Organic Farming Works farm in Minnesota and Organic Seed Alliance to develop this variety as part of the Northern Organic Vegetable Improvement Collaborative. And a third example is 'FBC Dylan' wheat, bred in partnership between the Northern Plains Sustainable Agriculture Society's Farm Breeding Club and a private breeder.

Lastly, while there are areas of large-scale, industrial organic production, many organic farms are highly diversified crop operations that are spread across the country and serve regional and local markets. There is a need to fulfill a wide range of plant breeding objectives for different environments and markets. Participatory approaches are an opportunity to address the wide diversity of breeding needs in an economical way.*

Organic variety trials

Beyond breeding in organic systems, there remains a need for more variety testing of both organic and conventional varieties in organic systems to determine which varieties are ideal for organic production and which varieties need improvement. Variety trials help breeders and other researchers identify varieties with useful traits for plant breeding projects.

Not all organic systems are alike. Climate, soil type, and nutrient management vary by farm and region. That's why organic variety trials are particularly important for helping farmers identify new and existing varieties that perform best on their farm and in their region, and that have specific qualities demanded by their markets. Variety trials provide farmers performance data that help them minimize the risk of adopting varieties they haven't tried before. Variety trials conducted in organic systems also help plant breeders and seed companies assess the performance of organic varieties and identify gaps in organic seed availability.

Some research has demonstrated a difference in the way varieties perform in organic versus conventional systems.[11] Other research, including the Carrot Improvement for Organic Agriculture project, hasn't found significant differences in the performance of varieties across farming systems.[12] Further research is needed to better understand why there are differences in results across projects to assist breeders in advancing traits that support superior performance under organic conditions and practices.

* Training farmers and plant breeders in participatory plant breeding methods was identified as a recommendation in our 2011 report. Since then, Organic Seed Alliance has published a *Participatory Plant Breeding Toolkit* to support researchers and farmers in developing projects using these methods

A number of variety trial networks have been created or expanded since our 2011 report. Many of these networks have been supported through the research investments discussed earlier in this chapter, and are multi-regional. A few examples that are currently funded through USDA's OREI program include: Carrot Improvement for Organic Agriculture, Eastern Sustainable Organic Cucurbit Project, Northern Organic Vegetable Improvement Collaborative (NOVIC), and the Tomato Organic Management and Improvement Project.

Examples of older and more established variety trial networks include the Northern Plains Sustainable Agriculture Society's Farm Breeding Club (FBC). Started in 1999, and based in the Dakotas, farmer members determine breeding projects and goals, and connect with one another and with researchers to actively improve, save, and share seed. Coordinator Frank Kutka says FBC has become more organized in the last five years and now has funding and university partners for organic variety trials and preliminary breeding of einkorn, emmer, cowpea, grain sorghum, radish, and vegetables. The club actively leads and engages in educational events, including webinars, workshops, and field days. FBC members released the previously-mentioned new bread wheat variety known as 'FBC Dylan', a modern and tasty type that does well in the region under organic conditions.

Another example of a variety trial network driven by a non-profit organization with a farmer membership base is the Practical Farmers of Iowa's US Testing Network (USTN). USTN began in 2009 with the purpose of coordinating a testing program to evaluate public and private corn germplasm for the organic and non-transgenic grain industries. Members include public breeders, private/independent breeders, seed retailers, and researchers. The network has experienced tremendous growth in field locations and membership, which grew from 19 members in 2012 to 30 in 2015. USTN now includes 64 testing locations across 14 states. In 2015, 13 of these locations were certified organic (in 2009, only seven locations were organic). USTN is interested in expanding organic testing to more locations but is finding it difficult to identify certified organic ground across all regions.

Other regional variety trial networks have been established in the Pacific Northwest (vegetables), Montana (vegetables), and California (wheat and vegetables). These regional networks are relatively new, as is a national network called the Experimental Farm Network, established in 2013 with the mission of "fighting global climate change and ensuring food security far into the future by facilitating collaboration on plant breeding and other agricultural research." One of the network's objectives is to create an open and easy-to-use platform for participatory breeding by connecting researchers and growers across the US.

Access to a central location for organic variety trial information was identified as a need in our 2011 report. Since that time, OSA and NOVIC research partners developed a national database of organic variety trial reports. It can be found at http://varietytrials.eorganic.info/.

Publicly funded breeders have more freedom than their private counterparts to address critical — yet potentially less lucrative — research that benefits organic agriculture

Summary

Though still in its infancy, organic plant breeding has grown into a scientific field and industry. Maintaining this growth to ensure organic farmers have varieties that are better adapted to their systems will require more investment and a coordinated strategy between public and private players and, importantly, farmers.

The goal of organic plant breeding should be to efficiently develop plant varieties that meet the needs of organic agriculture while using methods that align with organic principles. Small- and mid-sized seed companies supplying organic seed often don't have funds for organic breeding programs and therefore rely on larger companies with organic breeding programs and the public sector. Meanwhile, our university plant-breeding infrastructure is weaker than it was 20 years ago. These programs are essential for supporting organic seed innovation and for training the next generation of plant breeders.

There are a number of challenges that are slowing progress in organic plant breeding. Through surveys, listening sessions, and interviews with public plant breeders and seed companies, we've identified the following recommendations for improving our nation's organic plant breeding infrastructure.

Recommendations

Increase private investments in organic breeding and other organic seed research While investments in organic plant breeding are on the rise, they're not keeping up with demand. There remains a need to increase public funding from existing sources while identifying new funding sources, including from the private sector. Since the first *State of Organic Seed* report, the organic industry has become more aware of the need and has increased investments in organic seed research and education. Still, examples of this are few and far between. There are countless opportunities for food retailers and processors to sponsor regional organic variety trials, organic breeding projects, and organic seed trainings for farmers. These investments support the success of the farmers growing their products, benefit the customers they feed, and support the organic industry more broadly.

Increase public investments in organic breeding and other organic seed research Congress should increase federal funding – and provide longer term funding by project – for organic plant breeding as part of USDA-OREI, SARE, RMA, AFRI, and other federal programs. These programs should encourage requests that encourage requests that emphasize organic systems, participatory approaches, farmer involvement, cultivar development, and training the next generation of plant breeders. Furthermore, the USDA should establish a separate funding area within AFRI focused solely on public cultivar development.

Prioritize successful models and approaches to organic plant breeding Participatory plant breeding methods are well-suited to organic breeding projects, and re-establish essential feedback loops that have been lost. Organic breeding needs different approaches not just because the production systems are different from conventional systems but because the values and principles of organic agriculture are different as well, from excluded methods in the organic standards to ensuring that seed innovation is shared and made public. Additional research in the methods, impacts, and outcomes of participatory plant breeding is needed to refine and train plant breeders and farmers in this approach for organic agriculture in the US.

Address the lack of resources directed toward other organic seed research priorities Beyond organic plant breeding, which is receiving the bulk of organic seed investments, research is desperately needed in the areas of organic seed production, seed-borne diseases, organic seed economics, and other priorities

identified by farmers, seed companies, and researchers. Our research analysis described in this chapter only uncovered a handful of projects related to seed production, policy, seed system development, and other non-breeding projects.

Expand the infrastructure of public and private organic plant breeding programs Breeders say they have limited access to appropriate certified organic acreage, winter nurseries, and greenhouses to conduct trials and breeding work. This includes access to organic research sites with appropriate pest pressures and access to locations for organic seed production. There is a need to further investigate the barriers to adequately address them. Breeders also report needing stable, longer-term funding to support staff and infrastructure. All of these factors slow the organic breeding process and create barriers for getting more universities involved in organic plant breeding.

Develop and expand existing organic variety trials at the regional and national level There is a need to improve the coordination and dissemination of variety trial results. This includes private-public partnerships that allow seed companies lacking breeding budgets to identify and access breeding material from universities and coordinate with other companies. Farmers and researchers also need updated resources on how best to conduct successful variety trials, including guidance on making evaluations more consistent, rigorous, and useful. Regional variety trial networks are emerging, but they need more financial support to increase coordination, reporting, and the dissemination of findings.

Develop and promote fair intellectual property models Restrictive practices regarding intellectual property rights can slow innovation in plant breeding. For example, utility patents and restrictive licensing agreements can remove plant genetics from the pool of resources breeders rely on to innovate. Patents and licensing costs also add financial and administrative burdens. Furthermore, breeders worry about unintentional patent infringement since it's difficult to know for sure what's protected under broad patents. Intellectual property models used in the public breeding sector should not impinge on a breeder's and farmer's freedom to operate. Licenses can be written so that they retain the rights of the breeder, including royalty returns, while allowing other breeders to use the variety for breeding and allowing farmers to save seed.

Improve access to GMO-free breeding material for at-risk crops Breeders need access to more breeding lines for major crops, especially corn, that are appropriate for organic seed production. Part of the problem, at least in hybrid seed corn production, is limited access to high-quality parent lines due to the unwillingness of the largest genetics companies to license more proprietary lines in an untreated form. Furthermore, contamination is difficult to avoid in some breeding lines, especially corn, and the burden of testing for contamination remains solely on the shoulders of the organic community.

Create systems for releasing new organic varieties to the commercial marketplace As new varieties are developed by public breeders and by farmer-breeders, mechanisms need to be developed to help these varieties get into the hands of farmers. Improving commercialization pipelines will require more coordination and support to get new varieties tested, produced, distributed, and maintained. This includes better networking between breeders and seed companies, coordinated testing networks, systems for quality assurance and stock seed management, and streamlined intellectual property and royalty negotiations.

Chapter 2

State of Organic Seed Supply

Organic plant breeding has limited value until varieties containing these improved genetics are available to farmers in the form of high-quality seed and in sufficient quantities. That's why commercial seed production is integral to organic seed systems. Producing high-quality seed, especially organically, requires special skills and experience. It also requires proper isolation distances and specialized equipment and storage. One of the most pressing needs for building the availability of organic seed is expanding seed production knowledge and capacity by crop type and region.

As mentioned, demand for organic seed is growing. Sales of organic products totaled more than $43 billion in 2015, an 11% increase compared to 2014. Food purchases represent $39.7 billion of this total. Yet the organic seed supply isn't keeping up with this growth, and most organic farmers still rely on conventionally produced seed for at least part of their operation.

We arrived at this conclusion through a national survey of certified organic crop farmers. We first conducted this survey in 2009 and then again in 2014. By conducting this survey every five years, we're able to measure progress in meeting the organic seed needs of organic farmers. The findings that follow represent the first five-year update to this national survey. For a description of our survey methods and full set of data, see Appendix D.

Below we break down our findings by crop type and then explore farmer perceptions, actions, and experiences regarding organic seed. The survey questions were designed to collect information in the areas of (1) farm demographics, (2) organic seed usage, (3) challenges in sourcing organic seed, and (4) the potential for increasing the availability of organic seed. Additional questions captured farmers' perceptions of organic seed and which crops and traits should be prioritized by organic plant breeding programs, among other questions that help to inform our understanding of the state of organic seed systems in the US.

Who took our organic seed survey?

First, farm demographics: We received survey responses from 1,365 organic farmers representing 47 states (approximately 300 more than our 2009 survey). Most respondents were from the West Coast, Midwest, and East Coast. California was under-represented, and we had fewer respondents from the Midwest this time, though in 2009 the Midwest was over-represented. This time around respondents more closely reflect the actual relative numbers of organic farms in the different parts of the US. We are comfortable claiming that 10% of certified organic farmers in the US responded to our survey based on the USDA's 2014 Organic Production Survey. Most respondents were certified organic for less than ten years, but there were more long-time certified farmers (certified 11-30+ years) responding to our 2014 survey than in 2009.

We made a new effort in 2014 to gather responses from a random sample through a separate survey.* The responses between the two surveys were very close – mostly within a couple percentage points. This separate survey adds more credibility to our findings and gives us confidence that farmers responding to our national survey weren't necessarily only those who are more willing to use organic seed.

How much organic seed is being used?

One question we asked in the survey was whether farmers had decreased or increased the percentage of organic seed they used over the last three years (2011-2013). Across crop types, 27% of farmers responding said they're already using 100% organic seed. This demonstrates a minor improvement compared to 2009 data, where we documented that 20% of farmers were using 100% organic seed.

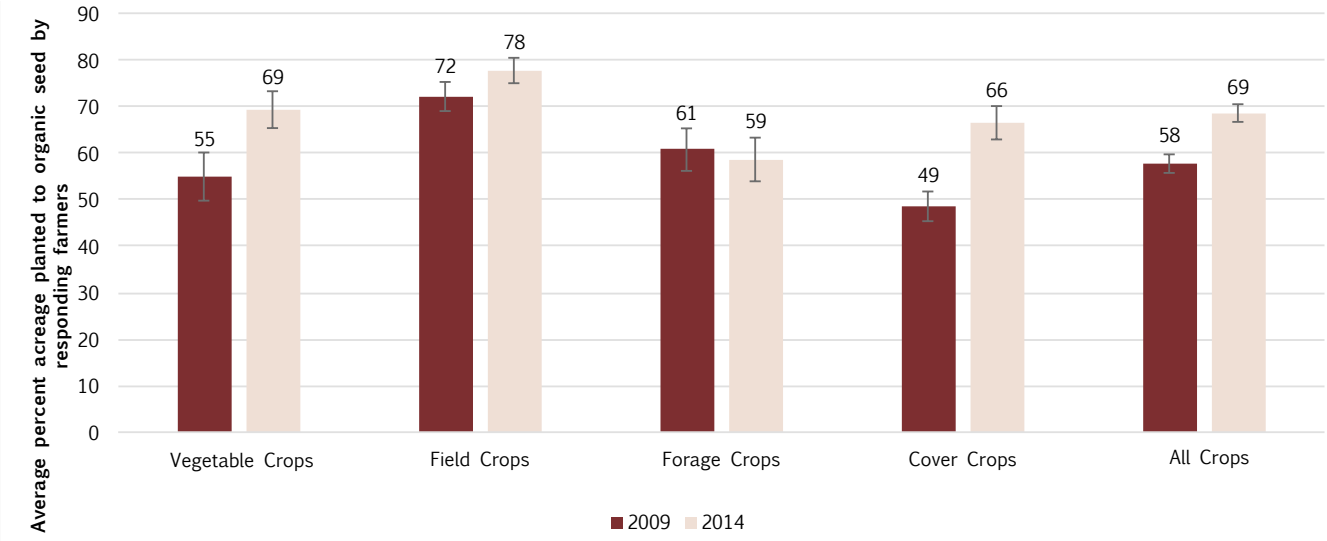
By crop type, vegetable growers demonstrated the most effort in improving their sourcing of organic seed. Nearly half (46%) of vegetable growers reported that they've increased their use of organic seed over the last three years. About one-third of field crop growers and cover crop growers, and one-quarter of forage crop growers, reported they've increased their sourcing of organic seed. Still, vegetables lag behind in an important way. Only 18% of vegetable growers reported planting 100% organic seed. Compare this to 30% who reported planting 100% organic seed for field crops, forage crops, and cover crops. Below we further break down this data by crop type (see Table 1 and Figure 6).

Table 1. Over the last three years (2011-2013) have you decreased/increased the percentage of organic seed that you use in the following crop types?

	VEGETABLES	FIELD CROPS	FORAGE CROPS	COVER CROPS/ GREEN MANURE CROPS	ACROSS ALL CROPS TYPES
Already at 100%	18%	30%	30%	29%	27%
Increased the percentage	46%	29%	25%	30%	31%
About the same percentage	31%	38%	42%	38%	36%
Decreased the percentage	5%	3%	3%	2%	6%

* Colleagues who reviewed our 2011 report pointed out the potential weakness of our data given the risk that farmers who chose to respond to the survey might be more supportive of organic seed than those not responding. This random sample survey was one way to address this concern and add more credibility to our 2016 findings.

Figure 6. Average percent acreage planted to organic seed



Vegetables

We had a slightly higher percentage of vegetable farmers responding to our survey in 2014 than in 2009 – about half of respondents grew vegetables, though these respondents represent less vegetable acreage compared to 2009. Most respondents had three or fewer acres in vegetables. On average, farmers reported planting about 70% of their vegetable acreage to organic seed. This represents a significant increase from 2009, when it was 55%.

Field crops

About half of the farmers responding to our survey grew field crops. The number was significantly less when compared to our 2009 findings, but this is likely because we had fewer respondents from the Midwest. On average, field crop growers planted 78% of their acreage to organic seed compared to 72% in 2009. More encouraging is that 56% reported using 100% organic seed for field crop acreage compared to 47% in 2009. Most respondents had less than 80 acres in field crops, whereas 13% of respondents had more than 480. Acreage totals were similar to the 2009 findings.

Cover crops

Seventy percent of farmers responding to our survey had cover crop acreage, and most had less than 50 acres. Half of these cover crop growers planted 100% organic cover crop seed, but 15% reported using no organic seed. The highest use of organic seed was seen in buckwheat (89%) and the lowest in rye (75%).

Forage crops

Fewer respondents planted forage crops in 2014 (38%) compared to 2009 (48%). Half of these respondents had less than 80 acres in forage crops. On average, 61% of forage crop growers planted their acreage to organic seed. This represented no real improvement in forage crop acreage planted to organic seed compared to the 2009 data.

Top three crops planted by farmers responding to our survey

VEGETABLES: tomatoes, lettuce/greens, squash
FIELD CROPS: wheat, soybeans, corn
COVER CROPS: buckwheat, vetch, oats
FORAGE CROPS: clover, alfalfa, grass

Challenges in sourcing organic seed

There are a number of reasons why organic farmers are not using more organic seed. The most significant reasons they gave include: specific varieties are unavailable in an organic form, there are insufficient quantities in seed, there is a lack of desirable traits, and price.

Although price is not an allowable reason for not sourcing organic seed under the organic standards, it remains a reported reason for organic farmers, though slightly less of a reason than we found in our 2009 survey.

All of these challenges are generally consistent across crop type but there are exceptions in vegetables worth noting. Most notable is how organic seed usage changes as acreage increases (see Figure 7). We found a general trend toward lower organic seed use among larger versus smaller vegetable growers. The difference is significant – farmers with less than 10 acres in vegetables on average plant 75% of their acreage to organic seed. Farmers with more than 480 acres in vegetables on average only plant 20% of their acreage to organic seed.

With the exception of seed saving, the general trend for vegetable growers is that the reasons they're not using organic seed become more significant as acreage increases. The biggest differences between small and large vegetable operations is that larger operations had more problems with the quantity of seed available, a buyer demanding a particular variety, price, or lack of desirable traits available in an organic variety.

In field crops, larger growers have more problems with the quantity of seed, buyers demanding particular varieties, and seed quality. Larger field crop growers are also less likely to buy organic seed because they're saving their own. We did not find similar trends in forage crops.

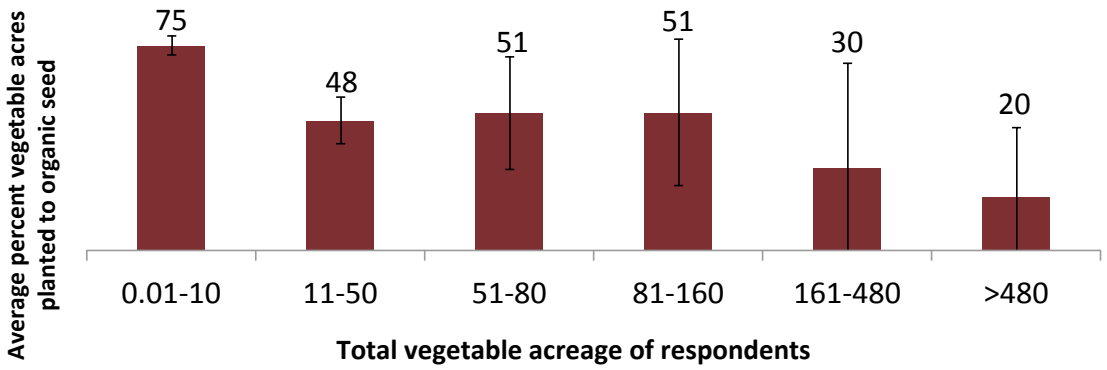
It's not surprising that seed quantity is an issue for larger scale farmers regardless of crop type. Buyer requirements are also an issue for larger operations of all crop types. These contracts, where organic food processors require that specific varieties be grown, is an important opportunity for identifying and fulfilling gaps in organic seed availability. Too often these contracts require varieties unavailable in an organic form. These relationships are also an opportunity to communicate crop improvement priorities directly to breeding and seed production companies, since farming challenges and market needs change.

> *Across all crop types, more than 30% of farmers responding to our survey are using more organic seed than they were three years ago*

Although more organic farmers report increasing their use of organic seed, from 2009 until now there is a general trend toward less total acreage planted to organic seed across all farms. Unfortunately, the small sample size in our survey of large-scale producers makes it impossible to say this definitively.* The takeaway is that we see farmers using more organic seed, but the operations still use relatively little and that has a big impact on overall acres planted to organic seed.

USDA data show that the number of certified organic farms increased as organic acreage decreased between 2008 and 2014.[13] There appears to be an increase in larger certified organic farms and a decrease in small organic farms that are exempt from the standards (farms that sell less than $5,000 in organic products annually). The fact that organic farms are increasing in size may not be bad in and of itself. However, this trend may serve as an obstacle to increasing acreage planted to organic seed given the slow progress we're making in increasing organic seed usage among larger operations.

Figure 7. Organic vegetable seed use by acreage



* We only had 13 responding farmers growing more than 160 acres of vegetables.

Reasons organic farmers are sourcing more organic seed

A number of factors contribute to farmers sourcing more organic seed. First, we know that more organic seed is available and being sold because that was reported by organic seed suppliers. As mentioned in Chapter 1, the majority of seed suppliers responding to our survey reported gross revenue increases from certified organic seed over the last five years. There are new companies participating on a commercial scale since our last report, but they're mostly under contracts with large-scale growers; however, some smaller companies now sell larger quantities to farmers either through direct contract or through wholesale purchases.

One new question we asked in 2014 focused on motivations for purchasing organic seed. We're happy to see that more than 80% of farmers responding want their organic seed purchases to encourage organic breeding. This finding matches other responses regarding the importance of organic breeding. For example, the vast majority of respondents believe that varieties bred for organic production are important to the overall success of organic agriculture, and that organic seed is important to the integrity of organic food production (85% of respondents strongly agreed or agreed with both of these statements).

Organic plant breeding priorities by top three crops and traits

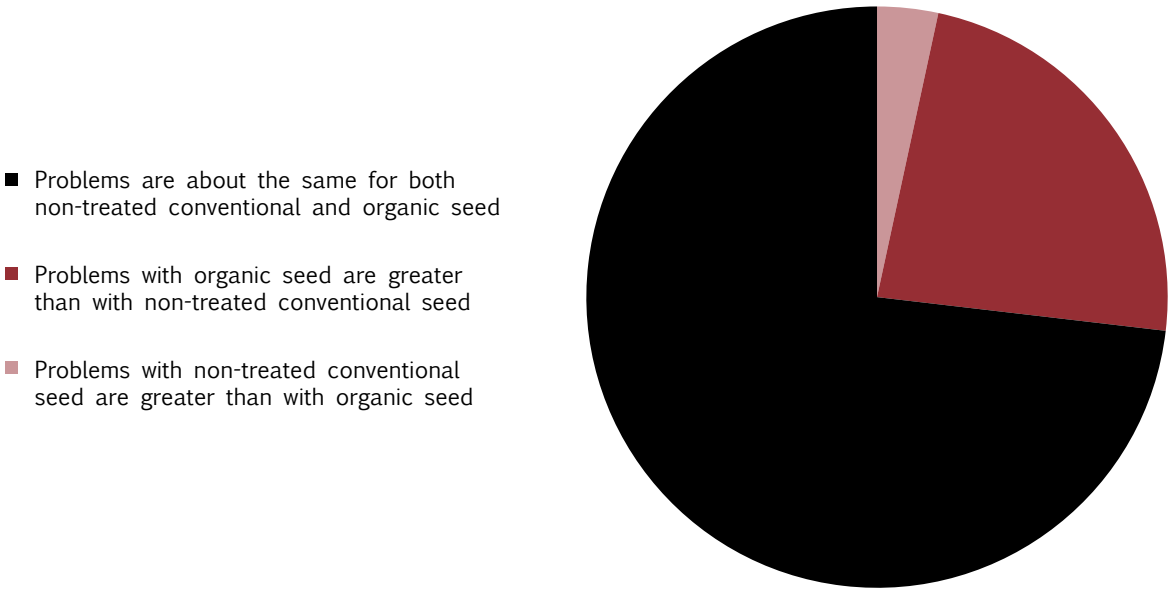
TOP FIELD CROPS AND TRAITS:
CORN: yield, germination, competitiveness with weeds
SOY: yield, disease resistance/tolerance, competitiveness with weeds
WHEAT: yield, competitiveness with weeds, nutrient use efficiency

TOP VEGETABLE CROPS AND TRAITS:
TOMATOES: disease resistance/tolerance, flavor, yield
BRASSICAS: disease resistance/tolerance, yield, appearance
SQUASH: disease resistance/tolerance, yield, appearance, quality

The majority of respondents report that there are crops in need of organic breeding. Organic plant breeding priorities remain almost the same as 2009 findings.*

Importantly, farmers report being more satisfied with the quality of the organic seed they're using (see Figure 8). Approximately three-quarters of farmers responding to our survey reported having about the same seed quality issues with organic versus untreated, conventional seed. This is in line with 2009 findings. Farmers also reported

Figure 8. In general, do you have more problems with seed quality issues in non-treated conventional seed or organic seed?

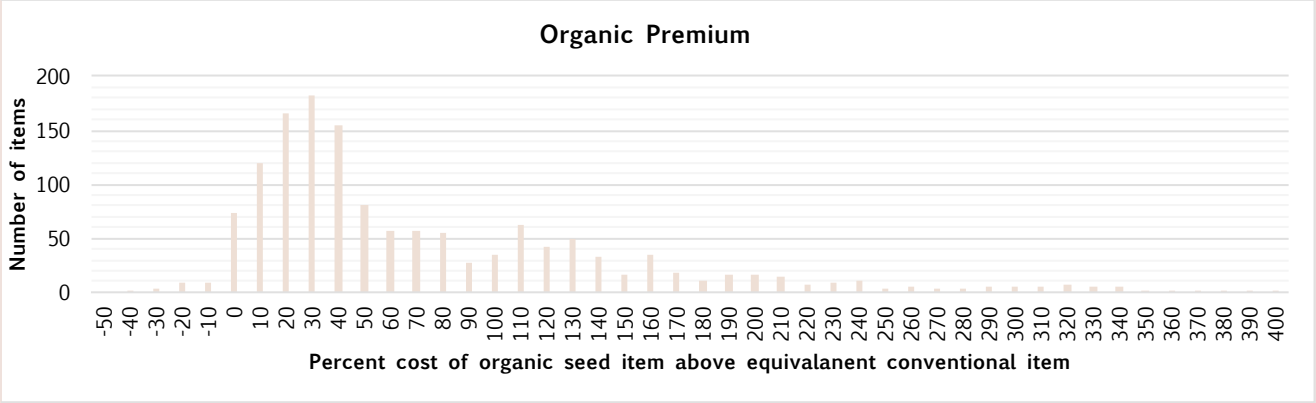


* Plant breeding priorities were nearly the same as the 2009 findings, although alfalfa was rated above wheat and uniformity was rated above yield for brassicas and squash in our last report.

How do conventional and organic seed prices compare?

According to an analysis of data provided by Pick A Carrot, the average price premium charged for organic seed was 65% above the conventional seed price. This is based on 473 varieties from 21 companies where a conventional and organic seed option was offered in the same units (e.g., both conventional and organic available for sale in 1000 seed units, or both conventional and organic available in one-quarter ounce units). Most prices were between 0 and 40% higher for organic seed, but the prices ranged from 40% cheaper to 340% more expensive. The companies listed by Pick A Carrot primarily sell vegetable seed, and therefore the varieties compared in this analysis are almost entirely vegetable varieties.

Although we do not have the same breadth of data for field crops, based on examples provided by field crop seed companies, the price premium is typically around 20-50%, with some examples where varieties cost about the same in conventional and organic seed and some examples where organic seed is more than twice as expensive.

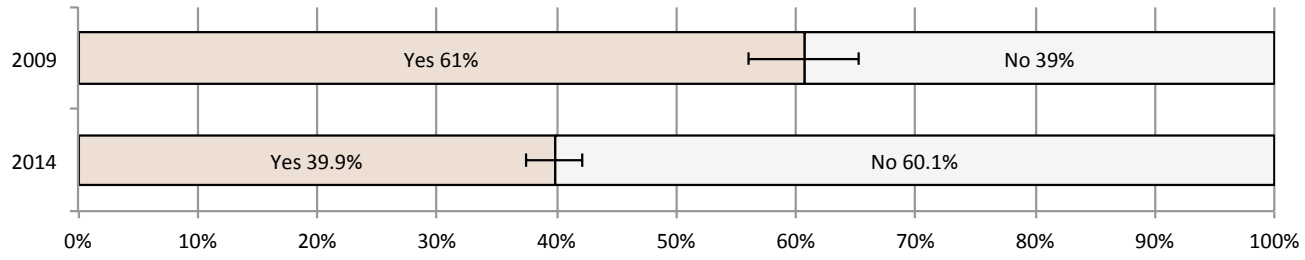


experiencing slightly fewer problems with organic seed compared to five years ago, especially with germination/emergence, not being true to type, and weed contamination. We found no significant differences in quality issues between crop types.

Organic certifiers also play an important role in increased sourcing of organic seed. Needless to say, it's no one's intention to enforce the organic seed requirement at the expense of an organic farmer's success. Farmers should not be forced to use an organic variety that may not be appropriate for their production system. Still, there's a need to encourage farmers who don't demonstrate continuous improvement in using organic seed to take extra measures to identify appropriate organic varieties, whether that's through variety trials on their farm or new seed sources. Certifiers have the important job of communicating the organic seed requirement, reinforcing the need for improvement when appropriate, and sharing resources to support increased organic seed sourcing.

In our farmer survey, we asked if certifiers had requested that greater steps be taken to source organic seed. We were surprised to see a marked decrease in the percent-

Figure 9. Over the last three years has your certifier requested that you take greater steps to source organic seed?



age of farmers reporting that certifiers made these requests (see Figure 9). Only 40% of farmers responding said their certifiers made such a request whereas more than 60% reported this request in 2009. Furthermore we found, just as we did in our 2009 data, that when certifiers requested farmers take greater steps to source organic seed, farmers responded by sourcing more organic seed (see Figure 10).

What progress have we made?

We've identified the following improvements over the last five years based on our farmer survey:

- More farmers report using 100% organic seed, especially field crop growers
- Vegetable growers in particular report increased sourcing of organic seed
- Farmers are more satisfied with the organic seed they're using
- More farmers believe organic seed is important to the integrity of organic food production and that varieties bred for organic production are important to the overall success of organic agriculture

Still, of the farmers responding to our survey, 126,000 acres (or 43%) of total acreage is planted to conventional seed. There are still areas where we haven't seen improvements:

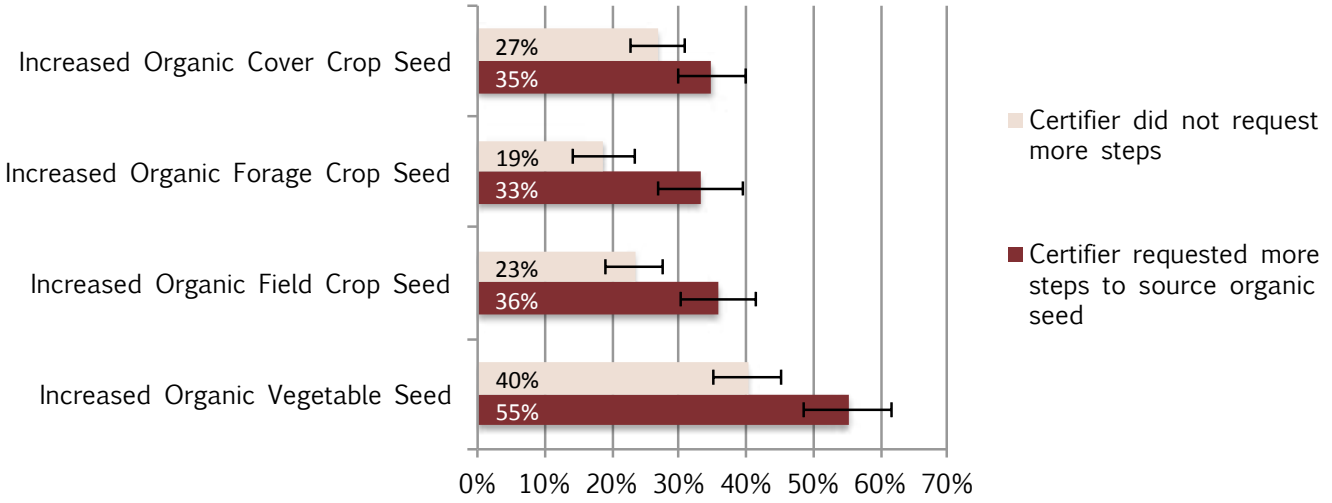
- Larger operations are still less likely to use organic seed
- Buyer requirements remain a barrier to using organic seed for larger operations
- Forage crop growers haven't improved their use of organic seed
- Farmers report fewer certifier requests to improve organic seed sourcing

How do we respond to the barriers farmers face when sourcing organic seed – from the availability of organic varieties with desirable traits to insufficient quantities in organic seed?

To better understand the challenges to increasing the availability, quality, and integrity of organic seed from a production standpoint, we now turn to more results from our organic seed company survey. The purpose of this survey was to assess the challenges and opportunities in growing the organic seed sector. (See Appendix B.1 for the list of survey questions.)

Sixteen companies responded to our survey. Half of the companies had a gross annual seed revenue of $1 million or higher (conventional and organic seed combined). Six of the companies had gross annual seed revenue of more than $2.5 million. Over the last five years, gross revenue has increased for all companies responding (1-20+%), with seven reporting increases of more than 20%. The majority of respondents reported that the percent of gross revenue from certified organic seed increased 1-20+%. Ten out of 16 respondents reported increases of 6-20+%. These numbers clearly demonstrate a positive trend in sales growth.

Figure 10. Certifier requests compared to increased sourcing of organic seed



These companies identified the following economic, production, and policy barriers to growing their organic seed business:

- Allowance of non-organic seed by the regulations and weak enforcement
- Lack of reliable and experienced organic seed producers
- Capital (infrastructure and marketing)
- Cost of organic seed production
- Seed production challenges (climate, pests, diseases, and scale)
- Lack of education (consumers and producers) on the benefits of organic seed
- Policies (GMOs, organic certification, and others)

Below we expand on these challenges as described by organic seed companies and note the progress we've made over the last five years in addressing them. These challenges were also echoed at the eight listening sessions held at organic farming conferences in 2014 and 2015, which involves diverse stakeholder representation. We also conducted interviews with farmers who produce organic seed under commercial contracts. We conclude this chapter with a full set of recommendations for expanding our nation's organic seed production capacity.

Allowance of non-organic seed

As discussed, the National Organic Program (NOP) allows certified operations to use untreated, conventional seed when an equivalent organic variety is commercially unavailable. Several seed companies cited this as the number one reason for slow growth in the organic seed industry. These companies believe that too many organic growers are using conventional seed when equivalent organic seed options are available. Some of these companies believe that stronger enforcement of the organic seed requirement is long overdue, especially for larger operations where price and scale are important factors. In one company's words: "Organic growers [are] using conventional seed even when organic seed is available in ample quality, quantity, and diversity, and certifiers and the USDA-NOP continue to allow it. This is predominantly perpetuated by large-scale organic growers who will avoid organic seed due to price differentiation." Another company pointed to "enormous loopholes for profit-driven, large certified organic operations [not using] organic seed."

One company shared that there is a "lack of certifier knowledge about availability and seed supply processes," adding that many large-scale organic operations have to contract organic seed the year before or there will not be enough quantity for particular varieties. This takes more effort and planning in the way of communicating and coordinating with seed production companies.

> *The vast majority of farmers responding to our survey agree that organic seed is important to the integrity of organic food production and that varieties bred for organic production are important to the overall success of organic agriculture*

In short, seed companies would like to see more consistent enforcement of the rule and more education for certifiers and inspectors on organic seed availability and sourcing issues, especially when it comes to differences in scale and seed sourcing processes. The organic seed requirement and its enforcement are discussed in more detail in Chapter 3.

Lack of reliable and experienced organic seed producers

As mentioned, producing high-quality seed under organic conditions requires a special skill set. The lack of skilled organic seed producers remains a major challenge to building the availability of organic seed. There's a need to expand seed production knowledge and capacity by crop type and region. There is also a need to greatly improve our national infrastructure for supporting these producers to ensure their success and long-term commitment to organic seed production – from providing high-quality stock seed to timely advice for troubleshooting challenges in the field.

One company reported that it's difficult to "find experienced, reliable growers," and another company relayed that "the talented seed producers have limited organic production capacity." Several companies identified "seed grower training" as a major need.

To illustrate the current situation: One commercial organic seed crop failure can mean a variety is unavailable that year. High Mowing Organic Seed's Jodi Lew-Smith put it this way: "As it's unfeasible to place duplicate contracts for every crop every year, one grower's crop failure can often mean a variety is not available as organic seed in our catalog that year, which sometimes means there's no organic seed for that variety in the marketplace at all."

And yet she believes the situation is improving. Lew-Smith says that overall access to organic seed producers continues to improve. Over the last five years they have twice as many growers who can grow high-quality open-pollinated and hybrid sweet corn, brassicas, tomatoes, and peppers. For these crops they mostly have enough growers and seed quality has generally been excellent.

Companies report fewer organic seed producers for peas and beans than there were five years ago. These crops are increasingly difficult to source, pests are a challenge, and seed quality remains variable. Companies report improved access to organic seed producers for spinach, chard, beets, and squash, but they say more growers are needed.

New organic seed mentorship program launched

In 2015, Organic Seed Alliance launched a mentorship program so that inexperienced growers can learn from experienced organic seed producers.* Seed producers and suppliers have long identified mentorship as a need, and the idea was repeated at a number of our listening sessions. The goal of the program is to provide beginning farmers with the necessary skills and knowledge to grow organic seed for the commercial marketplace. Working closely with seed producers and seed companies, OSA is developing a curriculum to help growers learn the basics of organic seed production. The curriculum includes seed production intensives and a webinar series that addresses timely issues throughout the growing season.

* This program is a partnership between OSA and the Multinational Exchange for Sustainable Agriculture. It was funded in 2015 by a grant from the USDA's Beginning Farmer and Rancher Development Program. In addition to beginning farmers, the program targets Latino farmers interested in organic seed production.

Scale is an issue reported by several companies: matching their needs to the scale that's comfortable for growers. For example, a company might not be able to sell as much as the grower would need to grow to use their equipment efficiently, and in other cases the grower can't grow and harvest as much as the company needs. In the latter case, the company has to place multiple smaller contracts – which can be more expensive on both ends. One company representative shared: "As the older, experienced growers phase out, they get replaced with younger growers who grow less seed and need a lot of mentoring."

One company says it actually needs more small-scale growers, but echoes the need for mentoring: "Our contracts are smaller than most and because of this a lot of the more experienced, larger growers don't want to use up an isolation on our small volume. We end up contracting out to very excited and passionate, but inexperienced, growers to varying degrees of success."

Training new and existing organic seed producers remains a top priority for the organic community. Since our 2011 report, Organic Seed Alliance (OSA) has hosted more than 40 organic seed production workshops in addition to webinars and other trainings focused on on-farm variety trials and plant breeding. In the words of one seed company representative: "The number one reason we have hit the ground running [with a number of organic seed producers] is because they were trained by OSA." Some organic seed farms and companies are also teaching workshops, such as Seven Seeds Farm in southern Oregon, Sierra Seeds in northern California, and the Farm Breeding Club.

In the last five years, some seed companies have taken on new staff charged with finding and supporting new organic seed growers, while strengthening relationships with existing growers – an encouraging investment by the seed industry. In the words of one of these companies, we need to "invest in long-term partnerships to grow organic seed production areas, train farmers, and co-invest in infrastructure to ensure larger production areas are growing with demand."

Also encouraging is that more organic farmers are interested in producing organic seed for the commercial marketplace. According to our farmer survey, more

than half of respondents are at least somewhat interested in producing organic seed commercially, and 90% of respondents are at least somewhat interested in taking organic seed production trainings. The top three factors keeping farmers from producing organic seed commercially include a lack of training, economic opportunities, and seed processing facilities.

Furthermore, 63% of respondents already produce organic seed for either on-farm use or commercial use. Seed producers identified the following challenges related to expanding their organic seed production capacity. They report needing more:

- Land in general and space for proper isolation
- Yield and economic data by crop and region
- Resources on production practices (weed, disease, and pest management)
- Support to troubleshoot production challenges (access to experts)
- Testing equipment and facilities (germination and GMO contamination)
- Scale-appropriate and affordable equipment
- Handling and storage facilities
- Marketing assistance

Seed producers echoed the need for more training opportunities, but said the problem goes beyond a lack of training in production practices. Some seed producers say they're set up to fail through poor stock seed, unfair contracts, and inconsistent communication from seed companies that don't have the capacity to provide production support or communicate effectively about other questions, like payments.*

High-quality stock seed for open-pollinated varieties is critical. If off-types or undesirable variability exists in stock seed, either the seed producer is forced to spend time and lose yield by removing the unwanted plants, or the ultimate user of the seed will receive a poor product. In interviews, some producers expressed frustration over receiving poor quality stock seed and being expected to "clean it up" with little guidance or compensation. Likewise, companies admit to not having good stock seed programs in place. Good stock seed management

* One company representative speculates that poor stock seed and frustrations with contracts and prices may be one reason more farmers are going out on their own to start new organic seed companies or sell directly to other farmers.

protocols typically separate seed stock growing from production seed growing, and typically schedule stock seed production on a more infrequent basis. However, as noted above, the limited number of skilled seed producers coupled with limited available isolations makes it challenging for companies to have separate production for stock seed and production seed.

One way producers are addressing some of these challenges is by developing cooperatives to share risks, costs, and equipment. There are a couple seed cooperatives in the US that are focused on addressing organic seed availability gaps and providing adapted varieties to particular regions. The first organic seed cooperative, the Family Farmer Seed Cooperative, was incorporated in 2008 and now includes 16 organic seed farms representing seven states. In 2015, the Triple Divide Organic Seeds Cooperative, based in Montana, officially launched with the mission of developing and selling regionally adapted varieties for their state and other northern latitudes.

These cooperatives complement a number of other small seed companies that are new within the last ten years. These companies not only aim to fill gaps in the organic seed supply but provide varieties that are better adapted to specific environments and regions. These companies also emphasize a commitment to engaging more farmers in their work and, in so doing, empowering farmers to participate in their own regional seed system.

Capital

In addition to a lack of access to skilled organic seed producers, companies report a lack of resources to build their infrastructure in a number of ways. Companies say they need more capital to train regional seed growers, invest in sales and marketing, and generally build scalable systems that support their growth. Infrastructure challenges also include access to land for growing organic seed and space for isolation.

> *Farmers and other stakeholders say they want more transparency in the organic seed marketplace — information about where seed was grown and whether any intellectual property restrictions are associated with the varieties*

More than one company mentioned marketing costs as a big challenge to growing their business. These costs add up in the way of advertising, conference registrations, and being away from the farm. In the words of one company: "Talking to other similar-sized seed companies, they are on the road a minimum of 80 days a year promoting themselves. It's very hard to be away from the farm that much for us, and to pay for all the expo, conference, and fair fees." But this company and others recognize the need to get "more exposure to a wider, more diverse group of customers."

Cost of organic seed production

Organic seed is sometimes more costly to produce than conventional seed for a number of reasons. Weed management is often a high expense in organic production and seed crops are a long season crop that requires extended weed control. Furthermore, lower yields can occur due to pest and disease impacts and the lack of plant protection chemicals in organic systems. In some cases certain diseases are a problem in seed production, but not in food production of the same crop. In many of these examples, plant breeders have not focused on addressing diseases that impact seed production since spray-on protections are allowed, often at higher rates, in conventional seed production compared to food production.

Access to appropriately scaled equipment and storage facilities can also impact the cost of harvesting and loss of seed yield in post-harvest handling. Isolation and testing for genetically engineered content in at-risk crops also contributes to increased production costs. Companies also report challenges associated with cash flow and managing inventory, paperwork, employees, and organic certification. Finally, organic certification requires that seed cleaning activities be conducted either on a certified organic farm or in a professional cleaning facility that is certified organic (though the facility can also clean conventional seed). The requirement for certified organic handling may serve as a disincentive for conventional seed companies to diversify into organic production.

A big economic barrier for one field crop seed company is that organic farmers often know they can make more money (and suffer fewer headaches) growing a

cash crop rather than seed. For example, most organic wheat growers, if approached, would probably not produce organic winter triticale seed and face low yields and a high likelihood of winterkill when they could produce organic winter wheat for the market. In this context, the only way a company can get growers to commit to organic seed production is to guarantee payment at the organic winter wheat level, which then makes the triticale seed prohibitively expensive.

Companies reported challenges associated with cost, including "small lots are expensive to produce" and the "lopsided business structure of seed sales" (all expenses up front to cover the course of the year). Another company pointed to the importance of paying employees fair wages, which also impacts production costs and capacity.

In addition to the expenses associated with organic seed production, one company referenced the "ceiling amount we can charge for seeds due to competition." This competition comes in a variety of forms starting with the lower price of conventional seed. More than one company pointed to the regulatory allowance of conventional seed, noting the "higher cost of organic seed production [while] at the same time [having] to compete with cheaper conventional seed." Competition also includes larger seed companies with international production that may be able to produce at a lower cost, potentially driving down prices. Additionally, one company pointed to "lots of start-up Internet businesses selling 'heirloom seed' of dubious provenance very cheaply."

Competition is a healthy characteristic of a seed system, and more players have entered the organic seed sector. But we heard repeatedly at our listening sessions that farmers and other stakeholders want more transparency in the organic seed marketplace – information about where the seed was grown, by whom, and whether any intellectual property restrictions are associated with the varieties.

Seed production challenges

As mentioned, organic seed production requires different approaches to pest, weed, and disease challenges given the lack of spray-on solutions and seed treatments available to organic growers. Unfortunately, organic seed production research is not keeping pace with evolving pest and disease pressures; however, we see progress in the form of 20 funded organic seed production research projects over the last five years. There were only 12 identified between 1996 and 2009.

Some examples include a project focused on seed diseases in the Northeast (funded by the USDA's Sustainable Agriculture Research and Education program); a manual on organic cover crop seed production for Southeastern growers, including economic analyses by crop (funded by Organic Farming Research Foundation); an organic seed production manual focused on climatic considerations (funded by the USDA's Risk Management Agency); and a graduate fellow at Washington State University studying organic seed pathology

(funded by Clif Bar Family Foundation). (See Appendix A.2 for a full list of funded research projects pertaining to organic seed production.)

Ongoing investments are needed to help organic seed producers and companies address production challenges. Seed companies report general research needs associated with pest, disease, and weed control, in addition to climate instability. Companies also report specific challenges. One company says it's difficult to find a consistent supply of organic pasture and hay grass seed, which is in line with our farmer survey findings where no progress is seen in the sourcing of organic forage seed.

Other challenges can't be answered with research. Companies note the challenge in finding proper isolation for growing particular crops on a larger scale – isolation to protect the integrity of a specific variety or to avoid GMO contamination. Companies report an ongoing lack of access to untreated hybrid parent lines for producing organic seed corn, as discussed in Chapter 3.

Lack of education

Many companies – and other stakeholders attending listening sessions – point to a need to educate farmers, gardeners, and consumers about the benefits of organic seed, what goes into its development, and why growers should be willing to pay the higher price tag. This stood out as a major recommendation coming out of new data collected through surveys and listening sessions. We've long heard that education on the benefits of organic seed is important, but it was communicated this time as much more urgent.

As one company noted, "consumers don't know the difference between a $0.99 seed packet and one that is $3.50." In the words of another company, there is a lack of "awareness of [the] benefits of regional seed, organic seed, and a small seed company." But it's not just gardeners who need to be educated. One company said that some organic farmers, especially those operating at a larger scale, are "somewhat dubious" about organic seed quality or are worried about the cost, preferring to buy cheaper seed. Brand allegiance and variety allegiance were also raised as a concern in the context of expanding organic seed sales.

We also have to work as an organic seed community to better understand how the seed systems we're developing work both at a domestic and international scale. Some companies cite a "misunderstanding by many players in the organic seed system about how seed varieties are developed, produced, distributed, and protected" and that there is "misinformation" that seed grown outside the US is ethically wrong or not supportive of a resilient seed system.

Finally, some companies are concerned that the value of organic hybrids is too often dismissed. Several companies also relay serious concerns about the difficulty in (and lack of) maintenance of open-pollinated varieties. In a similar vein, while genetic variation can be celebrated and useful, too much genetic variation within organic varieties in the marketplace has the potential to hinder growth in organic seed sales if customers expect more uniformity.

Policies

Policy is an important component of our roadmap for expanding organic seed systems, as discussed in Chapter 3. Through our seed company survey we identified policy concerns as they relate to inhibiting growth in the industry. Regulatory enforcement of the organic seed requirement has been mentioned, and will be further discussed in the next chapter. Other policy issues include state seed regulations, organic certification, and GMOs.

One company notes its biggest challenge to increasing sales is complying with individual state regulations, applications, and fees, and trying to decide if it's worth selling in certain states. Another company said it would be nice to have "common seed labeling requirements by all states for all retail seed suppliers." While all companies face this web of regulations, resources and education could help organic seed companies more easily navigate them as they grow and expand nationally.

Another company mentions state policies as they relate to crop disease outbreaks. Organic seed producers say these policies often don't work for them. For example, in the case of black leg disease in the Pacific Northwest, the policies in place to test and treat seed are designed for large conventional seed companies. "Some can argue," this company says, "that black leg is here because

of these conventional systems and yet it's smaller organic growers that are unable to afford the legally required test or treatment."

Organic certification can be a challenge for some seed businesses. The USDA's Organic Cost Share Program helps alleviate costs for operations, but one company says it's more than cost:

> As seed growers we find that the certification process is not understanding of our different needs. The processors certificate and handlers certificate (we need both) are designed more for produce and not our systems. We need more organic seed companies and maybe the fact that certification doesn't seem to have seed companies in mind in the first place is one of the hurdles.

Lastly, GMOs were reported by a number of companies as inhibiting their operations. The burden was described in the context of having to pay for testing and challenges with finding appropriate isolation to avoid contamination by unwanted GE material. One US-based company is trying to produce its organic alfalfa seed varieties in Europe to avoid contamination but has faced enormous hurdles given restrictions on imports, even when extensive testing shows the seed being shipped has no GE content. This company also noted "confusion about the allowable levels [of GE content] in organic seed and food" and that we need to "increase access [to] and test non-GMO corn and soybean lines across the nation to make the organic seed supply more robust."

In 2011, OSA conducted a survey of organic seed companies focused on risks and costs associated with GMO contamination. We were especially interested in challenges for organic seed corn companies, given how easily corn cross-pollinates. Some of the seed companies responding to this survey reported an inability to access a good diversity of high-quality germplasm for organic hybrid seed corn production.

As will be discussed in the next chapter, many of the best inbred corn lines are only accessible through onerous licensing agreements with the largest chemical and biotechnology companies. At times the licensing agreements also restrict testing for patented GE traits. These companies don't have an interest in serving the organic sector, as evidenced by their decision to make relatively few untreated inbred lines available. Addressing the barriers to accessing appropriate lines for organic seed production is critical to increasing organic corn and seed offerings.

Summary

The organic seed supply isn't keeping up with rapid growth in the organic food industry. Most organic farmers still rely on conventionally produced seed for at least part of their operation. Through a national survey of certified organic crop farmers, a survey of organic seed companies, listening sessions, and interviews with organic seed producers, we've identified the following recommendations for expanding organic seed systems

at the production level. In particular, there are a number of recommendations for growing the base of skilled organic seed producers and supporting the success of existing producers.

Recommendations

Train more organic seed producers and support existing producers Organic seed producers need more training opportunities and educational resources, ideally by region, since climates, environmental conditions, and appropriate seed crops vary. There's a need to train organic seed producers in a variety of crops and at different scales, and in hybrid seed production as well. University programs could develop curriculum on organic seed production as part of their education offerings. More grower-to-grower mentoring is also needed, as is support for conventional seed producers to transition to organic.

Develop region-specific resources on production data and practices Organic seed producers need yield and economic data by crop type and region. This is an ongoing gap in organic seed production resources. The organic seed community could begin by developing an organic seed crop yield database. Organic seed producers also need more resources on how best to manage diseases, weeds, and pests. Seed companies could be more transparent in sharing production volume and sales data to encourage new producers to enter the market.

Create regional and national seed producer networks Many organic seed producers are challenged by a lack of access to appropriate seed harvesting and cleaning equipment. They also report needing more support with handling and storage. Networks are growing on the Internet and through NGOs interested in coordinating seed growers at a regional and national level. Strengthening these networks will support the success of current organic seed producers and help new growers enter the market. Already these networks are helping growers share equipment and connect with seed suppliers – and supporting them in other ways as well.

Develop contracts that share the risks of organic seed production Seed production contracts often place risks in production on seed farmers without premium payment or assurances from seed companies. These risks include managing seed crops without chemical controls, GMO contamination, and poorly maintained stock seed. This compounds contract prices that are at times marginally profitable and can lead to growers leaving the organic seed production business. The organic seed industry might explore other payment models, such as paying by acre versus pound of seed produced for high-risk crops, or offering a secure minimum in the event of crop failure or low yield – therefore sharing the risk and reward of production.

Protect producers from the economic risks inherent to seed production Whole Farm Revenue Protection is a relatively new program that rewards farmers for being diversified and insures crops at the full organic price without any cap amount. The diversification incentive lowers a farmer's premium for each crop (up to seven crops). Organic seed producers should consider participating in this program to guard against losses, and the USDA should continue expanding the number of organic commodities covered. Furthermore, seed producers should be paid a price that's competitive with other organic crops that receive premiums. Without volume of sales, seed companies and seed producers can't invest in efficiencies to lower costs, and seed companies can't increase prices they pay to seed farmers. This threatens to further reduce the capacity of organic seed production.

Invest in organic seed production research and education Organic seed producers struggle to keep up with evolving disease and pest pressures. More research is needed on solutions to these and other production challenges. Research is also needed on production practices by region, such as crop spacing, timing of planting, and fertility. We also need more seed production trials to find varieties best suited to production in a region based on vernalization, day-length, temperatures, and more. More research is also needed on organic seed treatments that enhance germination and reduce risk of disease. There's a need to identify gaps in organic seed production research and resources through a survey of seed producers and suppliers, and use these findings to develop research projects, manuals, and other training tools that fill these gaps.

More than 60% of farmers responding to our survey already produce organic seed for either on-farm use or commercial sale

Develop quality assurance programs Organic seed producers need access and resources to support testing, from germination to GE content. Some seed companies and cooperatives need information and advisory support to develop internal quality assurance programs. There's also a need to explore possible third party quality assurance models that could serve the organic seed industry, such as those offered by some state crop improvement associations.

Develop and improve organic stock seed programs Seed producers rely on high-quality stock seed when growing a commercial seed crop. Seed companies could benefit from additional training on stock seed production, including: (1) setting up a stock seed production schedule; (2) creating clear ideals and selection protocols for each variety; (3) identifying growers with the skill set, scale, and appropriate environment for stock seed production, and paying them appropriately for occasional stock seed grow-outs; and (4) creating long-term stock seed storage facilities to reduce the frequency of grow-outs. Organic seed producers also need training in stock seed production. Educating and working with state foundation seed programs might be one way to expand and improve organic stock seed programs.

Assist new and existing enterprises with marketing constraints A central database that provides a comprehensive list of the organic seed available is still needed. Since our last report, two websites have been developed to serve this need: Organic Seed Finder and Pick A Carrot. These platforms help us understand supply and demand, but full participation by the organic seed industry is necessary to create a useful list of organic seed available in the marketplace. There's a need to better understand barriers to, and incentives for, seed company participation to ensure that a robust resource is available to organic farmers, organic seed companies, and organic certifiers.

Develop a public education campaign to promote organic seed Organic seed offers broad public benefit, including minimizing environmental impacts, supporting the success of the organic food industry, and bolstering regional food diversity and security. The success of the organic seed industry requires market support. Public education campaigns are needed to build this broad base of support and financial investment through market choices. By showing the benefits of organic seed, a public education campaign can build broader stakeholder support for organic seed and for the actions recommended in this report.

Work with organic food processors that contract particular varieties One hurdle to larger scale farmers sourcing organic seed is that production contracts dictate what variety they grow, and too often the variety is not available in an organic form or in the quantity they need. There's a need for more communication to coordinate organic seed production contracts in time for planting. Buyers that require specific varieties be grown under contract should work with their contracted operations to communicate variety and volume needs to organic seed companies. This effort must be coupled with stronger enforcement of the organic seed requirement to encourage this kind of relationship building.

Chapter 3

State of Organic Seed Policy

Policy work is essential to building and protecting organic seed systems. Laws and regulations impact each part of these systems — from how much public funding is directed toward organic plant breeding to policies that aim to keep genetically engineered (GE) traits out of organic seed. It's imperative that, as an organic seed community, we engage in advocacy to advance shared policy priorities.

Broadly speaking, advocacy efforts should confront threats to the development and integrity of organic seed while educating the public – consumers, farmers, and decision makers – about the benefits of organic seed systems. As already discussed, beyond helping farmers meet a regulatory requirement to use organic seed, the benefits of expanding organic seed systems are potentially far-reaching: a healthier people and planet.

This chapter discusses five advocacy priorities for supporting the development and long-term success of organic seed systems. These priorities include addressing the following challenges:

1. Inconsistent enforcement of the organic seed regulatory requirement
2. Contamination by GE crops
3. Increased consolidation in the seed industry
4. The privatization of seed and impacts on organic seed innovation
5. Insufficient public investments in organic plant breeding

We explore these priorities by describing the problems that need to be addressed through policy reform, guidance, and education, and conclude with updated recommendations to serve as an organic seed policy agenda for the next five years.

Inconsistent enforcement of the organic seed regulatory requirement

The National Organic Program's (NOP) regulations state that producers "must use organically grown seeds, annual seedlings, and planting stock" to ensure organic integrity along the entire production chain.[14] Because the supply of organic seed was inadequate when the NOP launched, the regulations provide a necessary exemption that allows farmers to use untreated, conventional seed, stating: "nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available."

The purpose of the current organic seed exemption is to provide a transition time for the seed industry to catch up to demand, with the goal of eventually achieving 100% organic seed usage when appropriate. The allowance for non-organic seed is important for growers who lack access to appropriate organic seed for their operations. As mentioned, it's no one's intention to force farmers to use organic seed that may not be optimal for their systems, yet the exemption has also proven a challenge to growing the organic seed marketplace. In the seed industry, some companies view increased investments in organic plant breeding and seed production as risky. They're reluctant to diversify and increase the volume of their organic seed offerings when non-organic seed (which is less costly to produce) is still an option for organic growers.

The exemption is also challenging for organic certifiers. The role of organic certifiers is to verify compliance with the NOP's regulations. As this compliance relates to seed, it's difficult for certifiers and inspectors to keep up on organic seed availability by crop type and region. Furthermore, the current regulations and guidance allow for a lot of leeway when determining whether organic producers have taken adequate steps to source organic seed. This leads to inconsistent enforcement of the organic seed requirement.

After the NOP was launched, organic producers and seed industry members relayed various concerns about how the seed requirement would be interpreted, implemented, and enforced. The National Organic Standards Board (NOSB) responded by creating a joint committee to address these concerns. As a result of their efforts, the committee provided the NOP detailed recommendations for guidance on the seed requirement in 2005 and again in 2008.

> *Beyond helping farmers meet a regulatory requirement to use organic seed, the benefits of expanding organic seed systems are potentially far-reaching: a healthier people and planet*

The NOP eventually published its final guidance document on March 4, 2013: "Guidance Seeds, Annual Seedlings, and Planting Stock in Organic Crop Production."[15] Many organic stakeholders, including Organic Seed Alliance, were happy to see the guidance released but disappointed by its contents, finding it left out critical areas that were suggested and strongly supported through the public comment process. Many of the NOSB's recommendations were not included.

In short, the final guidance doesn't:

- Encourage producers to take extra measures for sourcing organic seed
- Address the issue of how producers of various sizes source their seed
- Establish organic seed usage as an Organic Systems Plan goal
- Clarify the issue of noncompliance
- Require the use of a national organic seed database
- Place any responsibility on buyers that require specific varieties be grown*
- Explain NOP's role in supporting increased sourcing of organic seed

* Buyers include wholesalers, processors, and other food companies that enter into production contracts with farmers.

Organic seed availability issues are complex, to be sure. Just because farmers have access to a number of organic varieties for a particular crop doesn't mean those varieties are adequate for meeting the needs of all farmers. Still, while the organic community is in general agreement that the organic seed supply hasn't caught up to meet the diverse and regional demands of organic production, the NOP's current guidance doesn't reflect the progress we've made in the organic seed sector since the regulations were written. For example, the number of companies supplying organic seed has grown tenfold and more educational resources and tools exist to support the sourcing and planting of organic seed.

Our main critique of the guidance can be couched as a failure to provide a framework for what continuous improvement – a concept embedded in organic certification – looks like and how to achieve it in the context of seed (see full critique and recommendations on pages 50-51). We believe producers who aren't meeting the organic seed requirement should be encouraged by certifiers to demonstrate improvement each year. This is also an issue of consumer confidence, since organic consumers expect organic integrity along the entire production chain – beginning with organic seed.

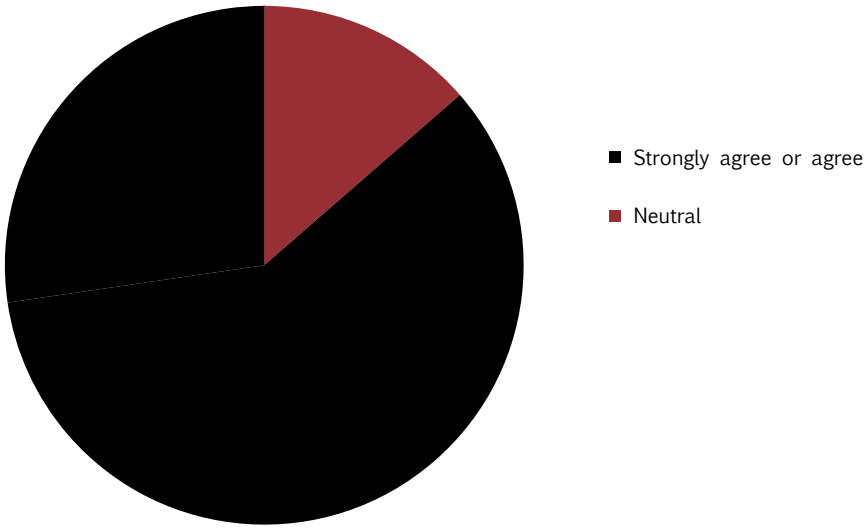
Getting the certifier perspective

The USDA has accredited 80 agents to certify organic operations, with 48 of these accredited certified agencies (ACAs) based in the US. In 2015, we distributed a survey to the US-based ACAs to better understand how the organic seed requirement is being enforced, challenges agencies face in enforcement, and what's needed in the way of education and resources (see Appendix C for the survey questions). Each question included a comments section to capture additional feedback. Most major ACAs responded to our survey – 22 respondents representing nearly 70% of certified operations in the US.

First we asked for certifiers' observations regarding market acceptance of organic seed. The vast majority of certifiers responding (86%) agreed or strongly agreed that organic seed is gaining acceptance in the market (see Figure 11). Certifiers explained in comments that they see progress in availability and sourcing. One certifier shared, "There seems to be more seed available over the past five years." Another remarked, "Many more farmers seem to trust that it is now high-quality seed and are purchasing organic seed with greater willingness. It seems quite often that organic seed supplies run out as well, indicating market demand."

Despite these perceived improvements in market acceptance, only 22% of certifiers reported that organic growers are making a greater effort to find organic seed. Nearly half of certifiers responding remained neutral on this question, with 31% indicating that most growers aren't making a greater effort to find organic

Figure 11. Percent of certifiers who agree that organic seed is gaining market acceptance



seed beyond consulting three sources. Comments suggested that more diversified operations, especially in vegetables, typically go beyond three sources whereas less diversified operations don't.

We also asked ACAs to estimate whether organic seed sourcing is improving more generally, focusing on vegetables and field crops. The majority reported that the use of non-organic vegetable seed (77%) and field crop seed (82%) has increased or stayed the same, indicating no perceived improvement. Certifiers were asked to report on the most common reasons operations they certify don't use organic seed. Their answers were in line with our farmer survey findings in Chapter 2, with the top five reasons being the specific variety wasn't available in a certified organic form, there was insufficient quantity of seed, a lack of desirable genetic traits, price was too high, and processor (buyer) demands varieties that aren't available organically.

About half (54%) of certifiers responding believe it's feasible to collect sufficient data from their clients to evaluate the commercial availability of organic seed (see Figure 12). Their comments provide ideas for how to better track commercial availability, including surveying seed companies to understand the supply side

Six Steps to Stronger Seed Guidance

The NOP plays an important role in impacting the success of the organic seed sector, and thus the organic industry as a whole, through policy guidance and certifier trainings. Below are six ways the NOP can strengthen its March 2013 document: "Guidance Seeds, Annual Seedlings, and Planting Stock in Organic Crop Production."

1. The final guidance should encourage producers to take extra measures for sourcing organic seed. As described in Chapter 2, our farmer survey suggests that when certifiers encourage organic producers to take additional steps to source organic seed – beyond consulting three sources – the result is increased organic seed usage. Producers who do not demonstrate continuous improvement in their organic seed procurement year-to-year should be encouraged to conduct additional research. This research should include consulting more than three sources and/or conducting organic variety trials on their farms. Furthermore, certifiers should consider, as part of their verifications, how producers of various scales source seed. For example, allowing large-scale operations to list three catalogs as evidence of insufficient supply should not be allowed long-term when larger growers likely have to contract organic seed production a year in advance. This will take extra effort on the part of certifiers and producers, but the long-term impact on the amount of acreage planted to organic seed will be enormous.

Recommendation: The guidance should be amended to call on certifiers to encourage producers who don't demonstrate continuous improvement in the context of seed to do additional research in the form of consulting more than three seed sources and/or conducting on-farm variety trials. Certifiers should also encourage large-scale producers to contract the production of organic seed for preferred varieties in advance.

2. The final guidance should establish organic seed usage as an Organic Systems Plan goal. There is currently no guidance in identifying specific Organic Systems Plan (OSP) goals for reasonable and measurable increases in organic seed usage, including plans for transitioning to organic varieties and reviewing increases by percentage used or acreage planted. While we're glad the guidance states that certifiers should review an operation's progress in obtaining organic seed by comparing current source information to previous years, the document lacks strong language indicating that this is an important OSP goal.

Recommendation: The guidance should be amended to encourage certifiers to work with producers to gauge measurable and reasonable annual increases in organic seed usage.

3. The final guidance should clarify the issue of noncompliance. The guidance is silent on the topic of noncompliance. Certifiers need more clarity and support on the issue. When does the failure to source organic seed become a major noncompliance? What evidence is needed to pursue suspension or revocation based on the use of non-organic seed? It's important that certifiers are provided with examples or situations where issuing non-compliances is appropriate.

Recommendation: We recommend the NOP provide examples of noncompliance through certifier trainings.

4. The final guidance should reference online tools. The NOP has endorsed a new organic seed database, Organic Seed Finder, as a resource for national organic seed availability data, and other resources exist as well, such as Pick a Carrot and SeedWise.

Recommendation: The NOP should proactively work to encourage organic seed companies to participate in Organic Seed Finder and other online resources. Referencing these tools would bring them to the attention of certifiers and producers, and encourage further engagement and investment. We also recommend that the NOSB and NOP work together on a process for reviewing organic seed availability each year to determine if and when there is adequate diversity and volume to require the use of organic seed for particular crop types. This could possibly be conducted in partnership with organizations hosting these online resources and public and non-profit research institutes conducting organic variety trials.

5. The final guidance skirts the responsibility of buyers. In the "Response to Comments" document published in conjunction with the final guidance, the NOP writes that handlers purchasing seed for contractual growing purposes are not subject to the seed requirement. Many handlers contract with producers to grow certain varieties, but too often these varieties are not available in a certified organic form. The NOP should require that questions about seed be raised during handlers' inspections and in their OSP, since these contracts, not growers, dictate whether organic or non-organic seed is purchased and planted.

Recommendation: The final guidance should be amended to apply to handlers who require specific varieties be grown (or that source seed directly) for contractual growing purposes.

6. The final guidance shouldn't explain the NOP's role. The guidance describes the role of producers and certifying agents but not the NOP, including efforts to ensure the guidance is effectively implemented. The NOP should provide certifiers and inspectors with trainings and information that assist them in guiding farmers in sourcing organic seed.

Recommendation: The final guidance should be amended to include a pledge from the NOP as referenced by the Organic Trade Association in its August 12, 2011, comments on the draft guidance:[16]

> The National Organic Program (NOP) will continue to address the use of organic seeds and planting stock during training programs for Accredited Certifying Agents (ACAs). It will emphasize to ACAs that they should monitor their clients' use of organic seed and planting stock for evidence of increased usage, including handling operations that make seed/planting stock purchase decisions. Monitoring by ACAs of organic seed or planting stock usage will be part of NOP's accreditation reviews of ACAs. NOP will encourage ACAs to regard non-compliances as a tool to be used when growers and handlers do not follow procedures intended to lead to greater usage of organic seed and planting stock.

better. One ACA says: "It would be helpful if seed suppliers provided a regional, quarterly newsletter that provides education and updates, such as types of organic seed that are typically readily available, types of organic seed that are not typically commercially available, and organic seed varieties that are currently under research." Right now certifiers recommend the following seed-sourcing tools: Organic Seed Finder (96% responding), NCAT/ATTRA organic seed listing (77%), and Pick a Carrot (55%).

Major constraints to evaluating commercial availability include the amount of time required to track this information and the potential impact on the cost of certification passed on to producers. More than one-third of ACAs responding (36%) said it isn't feasible to evaluate equivalent varieties when their clients claimed they weren't able to source organic seed (another 31% say it's feasible and 27% remained neutral). One certifier notes that, while it would require additional time and database functions to track this kind of information, it wouldn't be impossible. Another one noted that ACAs "are likely aware of crops that are consistently not available in organic form." Several comments point out that certifiers don't have the expertise to contradict commercial availability information provided by operations since so many factors play into seed decisions, from climate to past experiences with varieties to market preference.

Echoing this sentiment, more than half of respondents (55%) agree that additional trainings are needed to help certifiers and inspectors understand seed issues from a farmer perspective. The vast majority of respondents (82%) agree that additional educational materials and outreach for organic farmers, such as access to organic variety trial data, would increase or-

ganic seed sourcing (see Figure 13). Comments point to the need for more research on organic seed, saying more data would help adoption.

We asked if stronger regulations were needed at this time. More than one-third (36%) of respondents said no, while more than 40% responded as neutral or not sure. Certifiers relayed wariness about strengthening regulations before the organic seed market is sufficient to meet the current and growing demand for organic seed. When asked about the NOP's March 2013 organic seed guidance document, more than half (55%) said the guidance makes it easier for ACAs to determine when seed can be categorized as commercially unavailable, while nearly 40% say they are neutral or not sure.

We asked if ACAs had strengthened their own polices and procedures as they relate to organic seed (see Figure 14). For those answering yes, we provided follow-up options for categorizing these improvements. The majority of respondents (68%) haven't strengthened their polices and procedures regarding organic seed. The balance reported encouraging operations to request seed in a timely matter (23%), search the Organic Seed Finder website (14%), conduct trials of available organic varieties (14%), research more than three seed catalogs (9%), and contract organic seed production (5%).

Some certifiers are going even further. One ACA shared that it audits all operations annually to determine what percent of total varieties used are organic, and then it looks for this percentage to increase each year. Others say they've made improvements, such as mailing lists of seed suppliers to the operations they certify, but that they haven't changed internal policies. Several comments point to limitations in enforcement: "In situations where the producer uses proprietary varieties, there must be a process for developing organic varieties." Another ACA says:

> Many growers are contracted to produce very specific crop varieties organically and do not have the choice to find an equivalent variety. It puts the ACA in the difficult position of telling the grower to justify that the characteristics of the variety, which the buyer selected, cannot be found equivalent to another variety. All they know is that they have to grow the crop organic for the buyer.

As discussed, ACAs play an important role in supporting the expansion of organic seed systems by communicating the organic seed requirement to certified operations and enforcing the rule in a reasonable and measurable way. Consistent enforcement will require more data collection, resources, and education to help certified opera-

Figure 12. Is it feasible for Accredited Certifying Agents (ACAs) to collect sufficient data from their clients to evaluate the commercial availability of organic seed?

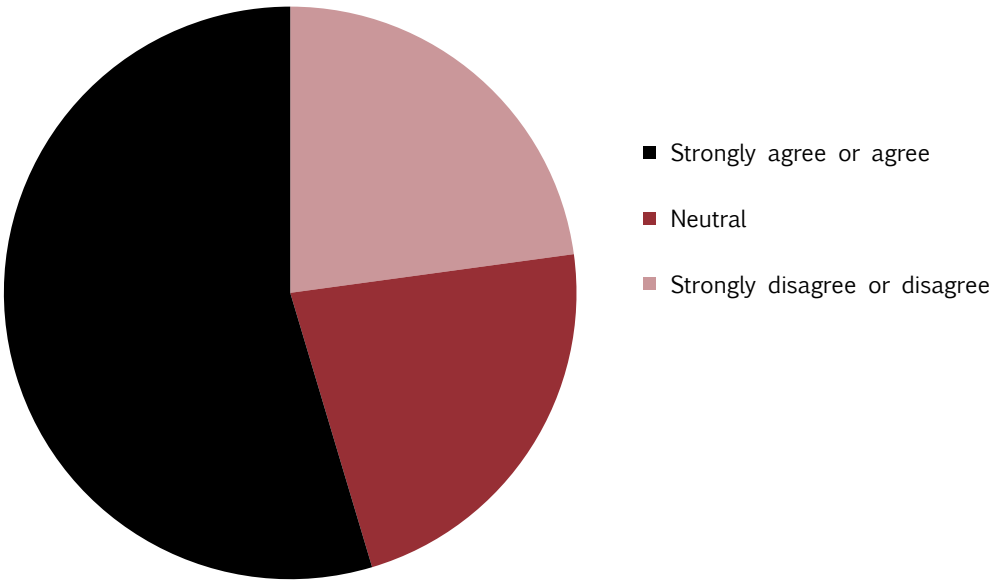


Figure 13. Additional educational materials and outreach for organic farmers, such as access to organic variety trial data, would increase usage of organic seed

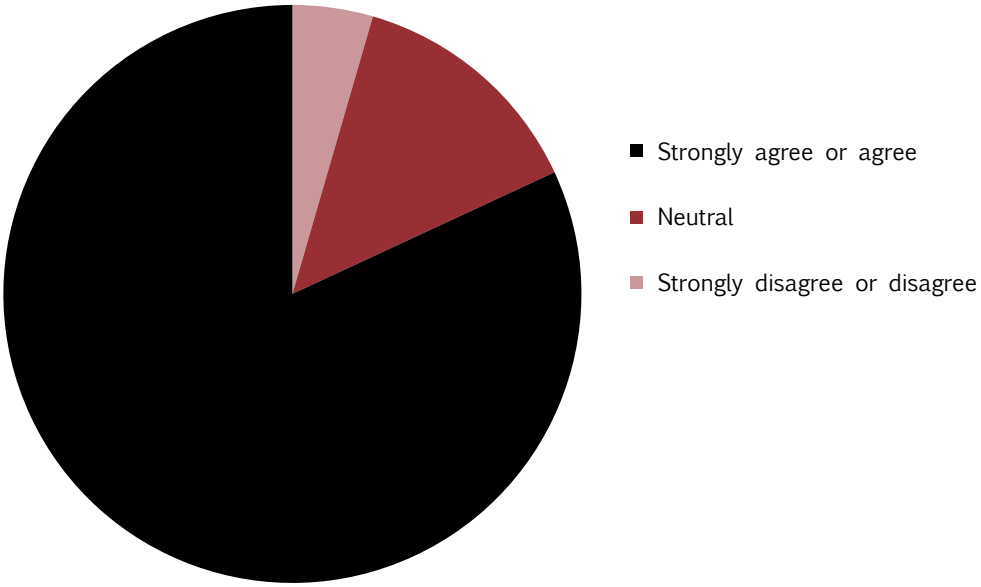
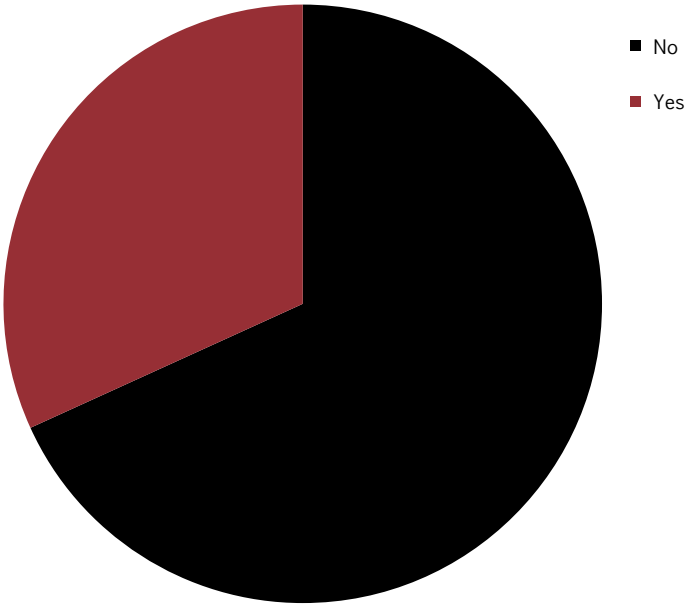


Figure 14. Have you strengthened your policies and procedures regarding organic seed over the last three years?



The purpose of the current organic seed exemption is to provide a transition time for the seed industry to catch up to demand, with the goal of eventually achieving 100% organic seed usage when appropriate

tions locate appropriate organic seed. These ideas are further described in the recommendations.

Contamination by GE crops

One of the most contentious issues in agriculture today is the planting of crops derived from genetic engineering, an excluded method in the organic standards. Genetically engineered (GE) crops, or genetically modified organisms (GMOs), are pervasive in our agricultural landscape where major field crops are grown. More than 90% of field corn, soybeans, sugar beets, and cotton are planted to varieties containing a GE trait.[17] Alfalfa, canola, papaya, sweet corn, and yellow summer squash also have GE counterparts in the commercial marketplace.*

Organic consumers reasonably assume that certified organic products don't contain GE material. Indeed, the organic community fought hard to exclude GE products from the organic program when the standards were developed in the 1990s. Therefore, the unwanted presence of GE material in organic seed and harvested crops remains a threat to farmers, seed companies, and food processors trying to protect the integrity of their organic products.

GE crops are like no other technology introduced to agriculture. For one, seed self-replicates whether deliberately sown by humans or not, making GE material impossible to contain completely. And, unlike other forms of harm, such as pesticide drift, the presence of GE material in organic seed and fields isn't easily detectable.

GE material continues to end up in organic seed, crops, and food products even when prevention measures are in place. The onus of avoiding the problem remains solely on the shoulders of organic producers and handlers. In fact, no other segment of agriculture works harder to provide a non-GMO product, since organic producers are required to take such precautions as part of their Organic Systems Plan. And when prevention measures fail, organic producers also shoulder costs associated with contamination.

These losses – in the form of rejected semi-loads or years of on-farm plant breeding work – aren't always documented or made public, but they can have serious impacts on producers and the suppliers they serve. While comprehensive economic data is needed, a number of surveys are helping us understand the impacts to farmers. For example, as part of the USDA's 2012 census of agriculture, organic farmers reported experiencing total monetary losses between 2011 and 2014 averaging approximately $66,395 per farmer, and more than $6.1 million in all.[18] This figure is 77 times that reported during the 2006 and 2011 time frame.

> *The US's patchwork approach to regulating biotechnology has left many holes, including the absence of mandatory prevention measures on the part of owners and users of GE crops, mandatory GMO labeling, post-market monitoring, and a mechanism for compensating growers harmed by contamination*

We're beginning to better understand the problem at the seed level. Our farmer survey, described in Chapter 2, found that most organic farmers (78%) want seed companies to test and report rates of GE contamination (See Figure 15). Most farmers responding (71%) also believe that federal regulations that oversee GE crop approvals aren't adequate for protecting their organic farm from potential contamination (see Figure 16).

In 2011, OSA surveyed companies that supply organic and non-GE seed to document the burdens associated with avoiding, identifying, and dealing with unwanted GE material in their seed lines. Our findings show that the majority of seed companies surveyed believe it's "very important" for seed companies to supply the industry seed free of GE traits. All of the companies test some if not all of their organic and non-GE seed products for the presence of GE traits. For some companies, testing is expensive, costing tens of thousands of dollars each year.

* Other GE crops have been approved over the last ten years, such as a plums, apples, rice, and potatoes – but just because certain crops have received approval doesn't mean they're in commercial production.

Testing and other costs add up even in absence of an industry-wide threshold for GE material. (The NOSB is discussing such a threshold, as described below.) Some seed companies are also losing revenue when they routinely sell organically produced seed to the non-organic market at lower prices because levels either exceed their internal threshold or are unacceptable to their customers. These companies say there's no mechanism available for recouping losses incurred by unwanted GE material. Courts may offer recourse, but companies say they can't afford to go to court to recover losses, especially if they're up against multi-billion dollar companies that own a high percentage of plant genetics used in the industry.

Figure 15. Seed companies should conduct testing and report rates of GE (GMO) crop contamination in organic and conventional seed (from our farmer survey)

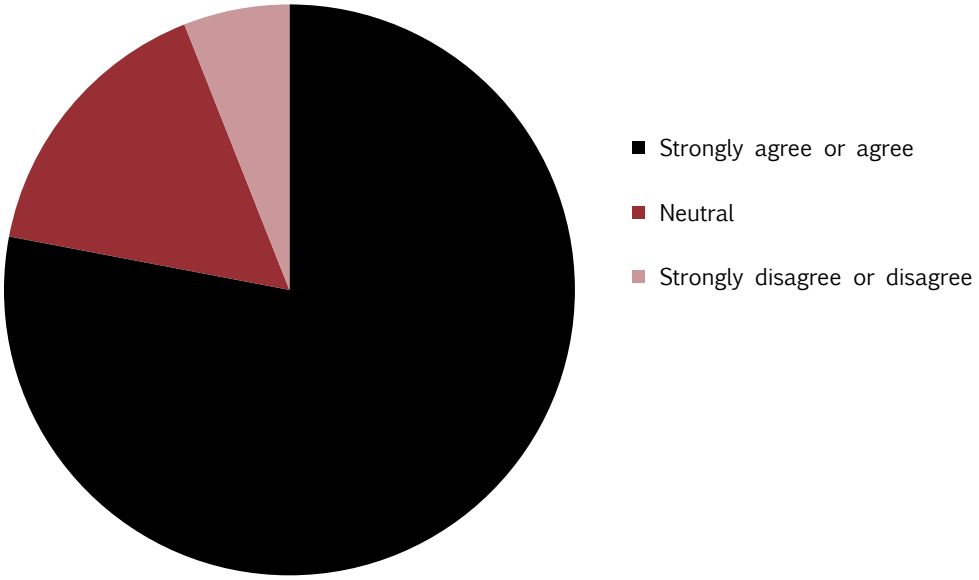
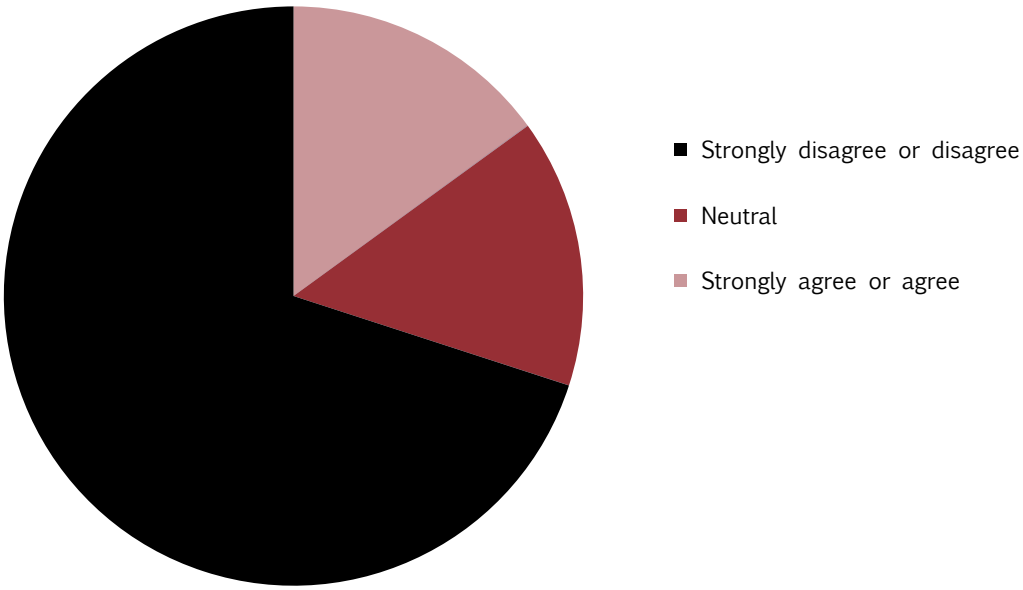


Figure 16. The federal regulations that oversee GE crop (GMOs) approvals are adequate for protecting my organic farm product(s) from potential contamination (from our farmer survey)



What would comprehensive GMO regulatory improvements look like?

The USDA could improve regulatory oversight by first implementing its broad noxious weed authority as defined by the Plant Protection Act. The law defines a noxious weed as "any plant or plant product that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the US, the public health, or the environment." Clearly, based on this language, USDA has sufficient statutory authority to issue regulations that address economic and other harms posed by GE crops.

The impact of GE crops goes beyond genetic contamination. Consequences, such as increased pesticide use, pesticide drift to neighboring farms, and impacts to biodiversity and soil health, are all real and common with GE products currently in use and those awaiting deregulation. USDA's current analyses are incomplete because they don't sufficiently include these broader issues, all of which are critical to the ideas underpinning "coexistence" – how one system of agriculture directly and indirectly impacts the viability of the other.

One glaring example is that in 2015 the USDA approved a new generation of herbicide-tolerant crops engineered to survive toxic chemicals known to cause severe health impacts: 2,4-D (a component of agent orange) and dicamba.* Just as other herbicide-tolerant crops have led to an enormous increase in herbicide use — Roundup Ready crops have led to an increase of 527 million pounds of herbicides applied between 1996 and 2011 — this next generation of herbicide-tolerant crops will lead to a huge increase in the use of 2,4-D and dicamba.[19]

Research shows that if 2,4-D corn is introduced, the US could see more than 103 million pounds of 2,4-D applied to corn fields by 2019.[20] By comparison, in 2010, about 3 million pounds were applied to US corn fields. And yet the USDA claims that it doesn't have the authority to look at indirect harms, such as the consequences of escalating herbicide use, damages caused by herbicide drift, and the development of herbicide-tolerant weeds, now regarded as one of the largest threats to production agriculture.

New regulations should also abandon the current petition process for "deregulating" GE organisms, because no GE product should be completely outside regulatory review. Furthermore, voluntary, non-regulatory approaches aren't acceptable. Companies that develop GE products shouldn't be left to regulate their own products. To that end, the USDA should fill existing regulatory holes by developing new, mandatory regulations that achieve the following:

Require that GE crop owners and users help prevent contamination Those at risk of contamination — including the organic community — shouldn't shoulder the burden of prevention, testing, and losses alone. New regulations should mandate contamination prevention protocols on the part of owners and users of GE products.

Conduct independent analyses of potential impacts resulting from GE crops We need ongoing oversight that is more comprehensive and coordinated, and that is based on rigorous, independent, and pre- and post-commercialization assessments of economic, environmental, health, social, and other impacts.

Provide stronger oversight of experimental field trials Current policies and oversight are woefully inadequate for preventing and identifying contamination events at the field trial stage. There needs to be more transparency, monitoring, and restrictions on outdoor trials.

Implement a fair compensation mechanism for those harmed by contamination When prevention measures fail, and producers and handlers experience contamination, companies that patent, promote, and profit from GE crops should be responsible for covering losses.

* In an interesting twist, in 2015 the Environmental Protection Agency (EPA) discovered that Dow AgroSciences made contradictory claims to the US Patent and Trademark Office about its Enlist Duo herbicide, the mixture of glyphosate and 2,4-D that is marketed to go hand-in-hand with the new generation of corn and soybean seed engineered to tolerate sprays of both herbicides. Dow told EPA that the mixture is no more toxic than either chemical when considered separately. The EPA approved the new herbicide but then discovered that Dow's patent application claims the herbicide offers something new: "synergistic herbicidal weed control." The EPA then asked the court for a chance to reverse its approval of Enlist Duo.

Companies also face barriers to eradicating GE material in their seed. For companies buying stock seed through licensing agreements with large genetics companies, these agreements often forbid activities that would allow companies to test for GE material in seed used to produce organic and other non-GE varieties. This is an example where GE products, and the intellectual property rights protecting them, serve as a barrier to growing the organic seed industry.

Advocating for stronger GE crop regulations

The USDA is one of three agencies that regulate GMOs (along with the Environmental Protection Agency and Food and Drug Administration). When these engineered crops landed in our fields and grocery aisles, US decision makers chose to rely on a patchwork of existing laws, many of which predate the technology, instead of creating a new law to oversee the novel products. This resulted in a mishmash of agency interpretations for regulating agricultural biotechnology.

The US's patchwork approach to regulating biotechnology has left many holes, including the absence of mandatory prevention measures on the part of owners and users of GE crops, mandatory GMO labeling, post-market monitoring, and a mechanism for compensating growers harmed by contamination, to name a few. Lacking a robust and coordinated regulatory framework, each agency has, in different ways, abdicated their regulatory responsibility.

Numerous local and state initiatives have attempted to fill the gaps in federal regulations and oversight. For example, since our 2011 report, more than 30 states have introduced mandatory GMO labeling bills, with Connecticut, Maine, and Vermont succeeding in passing legislation. (Vermont's will be the first to go into effect in July 2016.) A number of county bans on planting GMOs have passed in California, Oregon, and Washington. Hawaii County also passed a moratorium on planting new GE crops. There have also been a number of lawsuits filed, including lawsuits to defend these county initiatives.

At the federal level, mandatory GMO labeling bills have been introduced, as have bills to preempt state labeling efforts and weaken oversight of GMOs more

Is 'coexistence' possible?

The urgency for new GMO regulations grows each year as the technology evolves and more GE crops enter US fields and the food supply. Following the 2011 approval of Roundup Ready alfalfa – the first GE perennial field crop and one of the most controversial approvals in history – US Secretary of Agriculture Tom Vilsack responded to the uproar by re-convening the Advisory Committee on Biotechnology and 21st Century Agriculture (AC21). The Secretary directed AC21 to develop an appropriate compensation mechanism to address economic losses and other actions that "bolster or facilitate" coexistence. "Coexistence" quickly became the buzzword out of the USDA.

This USDA-appointed committee is largely made up of individuals representing the interests of biotechnology, but a handful of organic representatives also serve. AC21 met five times in 2011 and 2012. The meetings were mostly unadvertised and there were few stakeholders in attendance. In 2012, AC21 published its recommendations. The organic community found the recommendations inadequate, as they dodge the issues of prevention and responsibility. Furthermore, AC21 recommended the federal crop insurance model as an appropriate compensation mechanism, where organic operations would pay for additional insurance to cover potential losses. This approach, where organic operations and taxpayers bear the costs, would only exacerbate the disproportionate burden on the organic community.

There were a couple good proposals in the AC21's recommendations. AC21 called on the USDA to conduct research on the state of contamination in the commercial, non-GE seed supply. The committee also asked that the National Genetic Resources Advisory Council (NGRAC) lend its expertise. NGRAC is another USDA-appointed group charged with providing recommendations on actions and policies related to the conservation and use of plant genetic resources. The Secretary asked NGRAC to help develop a plan for evaluating the commercial seed supply, with an emphasis on ensuring that diversity exists to meet the needs of all farmers, including organic. NGRAC's recommendations were strong, and the Secretary approved them in June 2016.

broadly. What remains a major need, however, is a dramatic overhaul of regulations for all stages of GMO development, including experimental field trials; environmental, economic, social, and food safety analyses; GMO labeling; and post-market monitoring. We need a truly coordinated approach to regulating GMOs across agencies and stages in product development.

It's important to understand that the USDA has been operating under regulations promulgated in the 1980s under authority provided by the Plant Pest Act of 1957. In 2000, Congress passed the Plant Protection Act, which wasn't so much a new law as it was a combination of three existing laws that give USDA authority to regulate products of biotechnology – the Plant Pest Act, the Plant Quarantine Act of 1912, and the Noxious Weed Act of 1974. Yet no new regulations have been implemented under the 2000 law since it passed. That's why when the USDA announced in 2015 that it would finally update its regulations – ditching a 2008 proposal it never acted on – the organic community was eager to engage in a new process to develop stronger and long-overdue regulatory improvements.

Barring the creation of an entirely new law that more appropriately fits the novel nature of modern biotechnology, USDA's current effort to update its regulations under the Plant Protection Act is an opportunity for the organic and broader non-GE community to advocate for stronger regulations that better protect the environment, human health, farmers, and sensitive markets from the direct and indirect impacts of GE crops (see page 56).

How has organic policy changed to confront GMOs?

In 2012, after receiving dozens of comments from the public on the topic of GMOs, the NOSB wrote a letter to Secretary Vilsack describing these concerns as they relate to organic integrity. The letter asked the USDA to fulfill its obligation to support the success of organic agriculture since the problem doesn't exist within the NOP, but is a result of other agency shortcomings, as described. The letter provided the NOSB momentum to further examine the problem.

Patents have the potential to remove valuable genetic material from the pool of resources that breeders rely on for improving agricultural crops

The NOSB then established a GMO ad hoc subcommittee to begin exploring new ways to address GMO contamination in organic. The subcommittee began looking at the feasibility of establishing a genetic purity standard for seed used in organic production systems. Two discussion documents were released on the topic for public comment in 2012 and 2013.* A policy proposal is expected in 2016. The subcommittee describes the premise of a potential seed purity policy in the following way:

> The public comments to National Organic Standards Board (NOSB) and NOP continue to indicate a strong concern by both producers and consumers of organic foods for stronger steps to limit the potential and/or unintended presence of GMOs. Seed may be the most impactful and efficient point in the supply chain at which GMO contamination of organic feed, crops, and food could be limited and controlled.

Paramount to the success of organic producers is access to appropriate seed. As discussed in Chapter 2, given gaps in the organic seed supply, most producers still rely on conventional seed for at least some of the crops they grow. A threshold for organic and/or non-organic seed may incentivize more investment in, and sourcing of, organic seed. However, the issue is complex.

One concern is the unintended consequence of a standard leading to less organic seed should a threshold create too much burden on seed suppliers. Fully understanding the feasibility of a threshold, especially by crop type, is important before establishing an industry-wide standard. For example, in certain years, if environmental conditions result in high levels of GE contamination in seed production regions (i.e., levels that exceed threshold), especially corn, this could result in no organic seed available to growers.

Some important questions to answer before establishing a seed purity standard include:

- How much of the at-risk seed commercially sold and planted on organic farms could meet proposed thresholds?
- Are seed suppliers willing to make GE content levels available to customers?
- Will seed production companies have access to enough high-quality germplasm that also meets the threshold?
- Can we meet market demand for organic seed with a threshold in place without increasing genetic uniformity in our fields?
- Can we meet market demand for organic seed with a threshold in place without concentrating ownership and management of seed into the hands of a few major suppliers? In other words, will some companies find the new policy too burdensome and opt out of supplying organic seed? Or, will some companies only make their top varieties available under this policy, limiting access to more diverse offerings?
- What's a reasonable timeline for implementing a testing and threshold requirement?
- Do we understand the extent of contamination at the seed level, including GE levels by crop type, the frequency of contamination, and presence in breeding lines, foundation seed, and commercial seed?
- How much of the ongoing contamination problem can be attributed to other routes of contamination after "clean" seed is sown, including pollen drift during crop production?

One challenge in this threshold discussion is the absence of any recourse for operations – seed companies, seed producers, and others – who find themselves in a situation where contamination is routinely a problem and a threshold can't reliably be met despite their best prevention efforts. There's currently no way to collect compensation for testing costs, prevention measures (e.g., opportunity costs of buffers), losses incurred

* Read OSA's detailed comments on NOSB's seed purity discussion documents at www.seedalliance.org.

from not being able to sell that seed, or costs associated with cleaning up seed lines.

This reality makes it that much more important to strengthen regulations and oversight for GE crops, as described on page 56, and implement a fair compensation mechanism. Without a safety net to cover incidences of contamination, the financial burden and risk for seed producers and suppliers may only increase with a threshold in place and could be passed on to farmers in the form of higher seed costs and/or fewer varieties. This could discourage further investments in organic seed because the costs of production might prove too high with the added challenge of meeting a threshold.

The NOSB explores changes to the 'excluded methods' definition

Since our 2011 report, the NOSB has begun discussing how best to address certain "excluded methods" as they pertain to plant breeding techniques. The organic community lacks a good understanding of how extensive controversial techniques are used, whether these techniques conflict with the principles of organic agriculture, and what implications a definition change may have on farmer access to seed. Meanwhile, the IFOAM World Organic Congress recently passed two resolutions on organic plant breeding that may affect breeding in the US. These discussions raise important and bigger questions, such as: Which principles and criteria should guide organic plant breeding decisions? Where does the organic community draw the line on certain methods?

Spurring this discussion were concerns that some plant varieties used by organic farmers were developed using cell fusion, a technique included in the definition of excluded methods.* There are plant varieties, especially in the Brassica family, that have been developed using cell fusion to confer desired traits in hybrid breeding programs, such as cytoplasmic male sterility. These techniques are used in other crops as well.

In response to these concerns, the NOP published a policy memo on February 1, 2013: "Cell Fusion Techniques Used in Seed Production."[21] In this memo the NOP concluded that:

> Cell fusion techniques are an excluded method when the donor cells/protoplasts do not fall within the same taxonomic plant family. Cell fusion is an excluded method when the donor or recipient organism is derived using techniques of recombinant DNA technology (including gene deletion, gene doubling, introducing a foreign gene, and changing the positions of genes when achieved by recombinant DNA technology), and techniques involving the direct introduction into the organism of hereditary materials prepared outside the organism (such as microinjection). However, the NOP further concludes that cell fusion (including protoplast fusion) is not considered an excluded method when the donor cells/protoplasts fall within the same taxonomic plant family, and when donor or recipient organisms are not derived using techniques of recombinant DNA technology.

* An NOP policy memo states: "In the scientific literature, cell fusion is defined as the fusing of two cells to form a single cell. Natural cell fusion is integral to plant growth; egg fertilization is one example. In plant breeding programs, cell fusion is used in many traditional breeding and hybridization programs as well as in general propagation using tissue culture."

Beyond cell fusion, dozens of techniques are being discussed by the NOSB, such as gene editing and synthetic biology. Policy discussions involving controversial breeding techniques are difficult because the broader organic community lacks sufficient understanding of the science. There's also a lack of data on how extensive some of these techniques are currently used by plant breeders, especially developers of organic seed. But the NOSB is making progress in developing definitions, principles, and criteria to guide these excluded methods discussions and decisions. Its proposal, expected in 2016, will help guide the evaluation of controversial techniques when determining if they should be excluded. The NOSB is also working on resources for certifiers and other organic stakeholders to consult when questions arise about the appropriateness of questionable techniques and products.

Increased consolidation in the seed industry

Consolidation in the seed industry hasn't slowed since our 2011 report, and major mergers and acquisitions continue to go unchecked by the US Department of Justice (DOJ). Dr. Phil Howard of Michigan State University has followed agribusiness concentration through articles and information graphics, including trends in the global seed industry. Howard's most recent research reveals that while corn, soybeans, and cotton are highly impacted by consolidation, the trend is growing in other crops, including vegetables, and that consolidation continues at a rapid rate. The top eight firms acquired more than 70 companies during a five-year period (2008 - 2013).[22]

As of the writing of this report, the largest players in the industry are discussing major mergers. A merger between DuPont and Dow Chemical (owner of Dow AgroSciences) is under regulatory review. ChemChina announced that it would purchase Syngenta in 2016 after Monsanto's bid to buy the Swiss company failed in 2015. And, in May 2016, Bayer announced a bid to purchase Monsanto.

Three firms (Monsanto, DuPont, and Syngenta) collectively control more than half of the global seed market, up from 22% in 1996. By crop type it's even more telling, where four major biotechnology and chemical firms command 86% of the retail market for corn.[23] The top two firms (Monsanto and DuPont) account for 66% of this market and 62% of the soybean retail market.[24] This level of concentration in corn and soybeans has meant less choice for farmers and skyrocketing prices.[25]

An expansion of intellectual property rights (IPR) awarded to crop developers facilitated the concentration of financial and genetic resources. The enormous profits from licensing patented products led to the acquisitions and mergers just described. Patents are expensive, so it's no surprise that the top two industry leaders that have profited tremendously from IPR on seed are also the top two owners of utility patents on plant varieties. Between 2004 and 2008, Monsanto and DuPont accounted for 60% of these applications.[26]

Yet, contrary to the claims of these IPR owners, patents and restrictive licenses haven't spurred innovation in crop improvement. In fact, the opposite appears true. For example, in plant biotechnology, the USDA documented that as the corn, soybean, and cotton markets became more concentrated "private research intensity dropped or slowed" relative to what would have occurred without consolidation.[27] Market protection in the form of antitrust oversight is needed to prevent undue concentration of economic power and encourage innovation.

In 2010, the DOJ and USDA began to take a hard look at anticompetitive conduct in the seed industry. The agencies hosted five workshops across the country to discuss competition and regulatory issues in agriculture. These workshops were historic. Never before had the two departments joined forces in an effort to examine antitrust issues in agriculture. And yet, despite well-attended public workshops and more than 18,000 written comments, the agencies failed to take action in response to the compelling evidence put forward.

The public comments represented a range of agricultural industries – from poultry to hogs to cattle – yet seed remained a prominent subject of public comments delivered at each workshop. Farmers called on the agencies to confront seed industry consolidation, to keep germplasm public and accessible to our land grant universities, and to address the abuse of utility patents as they are applied to seed, among other strong requests.

The privatization of seed and impacts on organic seed innovation

Awarding utility patents to seed developers is relatively new. Congress long argued that sexually reproducing plants shouldn't be awarded utility patents – "patents for invention" under the US Patent Act – for fear of curtailing innovation, threatening the free exchange of genetic resources, and increasing market concentration. But the seed trade was eventually successful in convincing Congress that more protection was warranted. This came in the form of a "patent-like" protection under the Plant Variety Protection Act (PVPA) of 1970.

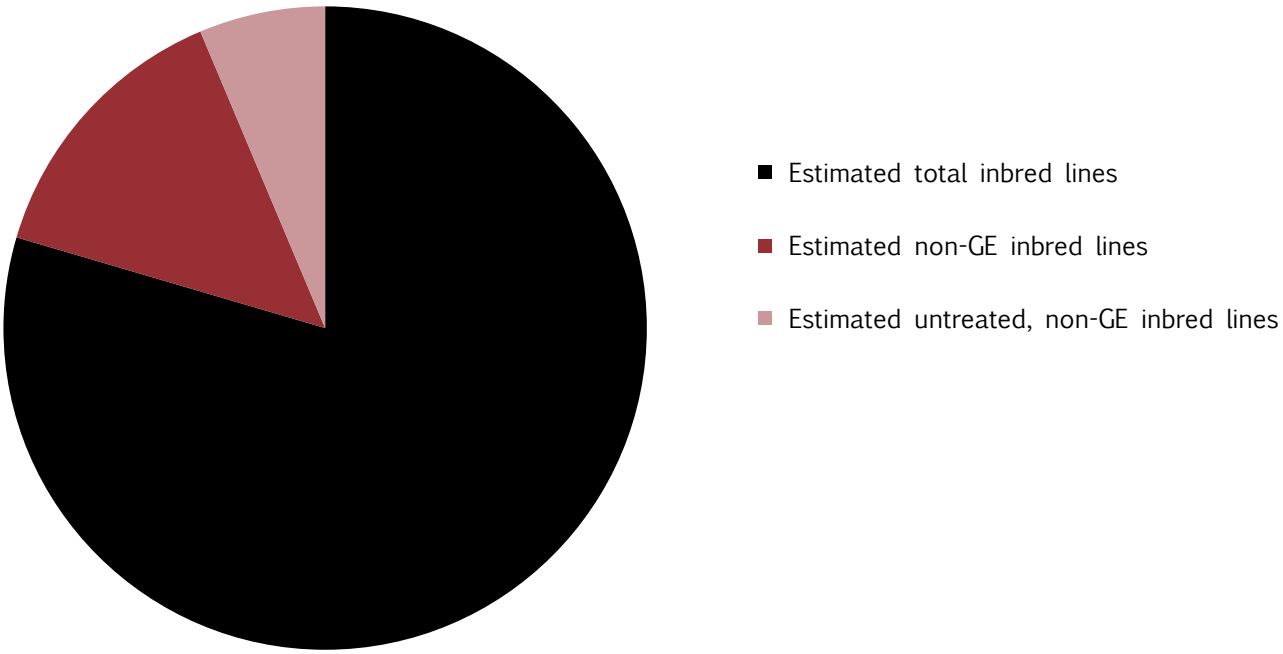
The law represented a compromise: Breeders have the exclusive right to propagate and market the variety for 20 years, but the law provides important exemptions: (1) protected varieties can be used for research, and (2) farmers can save seed from protected varieties to replant on their farm. Although many breeders still use PVP protections today, Congress's concerns regarding intellectual property and plants have been realized – but not because of this law. At the turn of the twenty-first century, the Supreme Court upheld a case where the Patent and Trademark Office (PTO) awarded the first utility patent on a lifeform. (The PTO had originally refused to award this patent, but the US Board of Patent Appeals and Interferences disagreed and granted it.)

Owners of utility patents have far-reaching control over access and use of their protected products. While the PVPA has exemptions for researchers and farmers, utility patents can be legally enforced to forbid access to protected genetic material for purposes of research as well as on-farm seed saving. Patents therefore have the potential to remove valuable genetic material from the pool of resources that breeders rely on for improving agricultural crops. What access breeders do have sometimes hinges on restrictive licensing agreements.

The abuse of IPR has not been well documented in the public plant breeding community. What we do know is that public breeders' experiences vary widely depending on the crop type and breeding program. Some public breeders haven't been impacted by restrictive IPRs, while others cite enormous constraints. It's also important to note that public plant breeding programs may use and rely on IPRs very differently than the private trade, where the latter more often relies on proprietary lines for income generated. In the words of one plant breeder, "I think that public and private breeding programs should be held to different standards regarding the 'acceptable' level of IPR because the funding sources are so different."

Nonetheless, the concerns of public plant breeders who feel constrained in their work by restrictive IPRs

Figure 17. Estimated comparison of corn inbred line availability



are worth noting. As one plant breeder remarked:

> I think utility patents are one of a number of factors that are impinging the loss of public sector plant breeders, limiting the potential for freely available germplasm. I think these are real concerns for the future. … I think that they have a chilling effect on breeding in the sense that if you knew that somebody was patenting or even trying to patent a trait that you were working on or thinking of working on, you'd likely stay away from it, because you'd try to avoid litigation or infringing on their patent, and that then means less plant breeding, less activity. Overall, I think for plant breeding, especially for the public sector, I think it's very, very difficult to work in that space. Public breeders are not in a position at all to begin licensing people's patents. We don't have that kind of resources to do that.

Another public plant breeder reiterates this "chilling" effect, adding, "utility patents can tie up everything, and that is the intent. There's germplasm I wouldn't touch as a plant breeder because companies could assert their rights under the patent." A number of breeders responding to our organic researcher survey (described in Chapter 1) identified restrictive licenses as an obstacle to using varieties they desire for their breeding programs, since some licenses prohibit breeding and other research – even simply including the variety in a trial.

How do these trends impact organic seed? As mentioned, one consequence is limited access to germplasm for breeding and seed production purposes, a trend that extends into the private sector. Similar to the public sector – where breeders' experience with IPR differs by crop type and program – the private sector's interaction with IPR also varies. For example, companies dealing with crops that have GE traits (or crops with GE counterparts) face more challenges than others. Hybrid seed corn companies that don't have breeding programs rely on licensing inbred lines for their seed production. The largest chemical and biotechnology companies that own most of these lines are unwilling to license them in an untreated form – that is, without chemical seed treatments prohibited in the organic standards. It's illegal to use these lines without a license.

The president of Albert Lea Seed House, Mac Ehrhardt, estimates that of more than 1,900 hybrid lines available, only 8% are available as a non-GE line and in an untreated form (see Figure 17). Field corn is one of the most widely planted organic crops in the US and yet choice in organic seed continues to be limited due to lack of access to appropriate lines for independent breeding and seed production. Furthermore, as mentioned, it's common for agreements to prohibit testing licensed lines for patented, GE traits. This puts companies that want to protect their reputation as a supplier of "clean" seed in a vulnerable position of risking litigation if they decide to test illegally.

As for impacts to farmers, patents on major field crops, like soybeans and cotton, have been enforced to restrict farmers from saving and replanting seed – the very practice that helped establish the tremendous diversity of domesticated crops and varieties we have today. By being forced to repurchase seed each year, farmers not only shoulder higher annual input expenses, they lose the ability to adapt seed to regional climates, soils, and disease pressures. They're removed from the seed system and relegated as an "end-user."

By being forced to repurchase seed each year, farmers not only shoulder higher annual input expenses, they lose the ability to adapt seed to regional climates, soils, and disease pressures. They are removed from the seed system and relegated as an 'end-user.'

Since our last report, lawsuits have challenged utility patents on life. In 2013, the Supreme Court of the United States ruled on two relevant cases: (1) the patentability of human genes, and (2) the patent exhaustion doctrine as it relates to saving patented seed. In the first case, at issue were breast cancer genes identified and sequenced by Myriad Genetics, a molecular diagnostic company. In Association for Molecular Pathology v. Myriad Genetics (2013), the Supreme Court unanimously held that "a naturally occurring DNA segment is a product of nature

and not patent eligible merely because it has been isolated," invalidating Myriad's gene patents.[28] (The decision reiterated, however, that the Court still views utility patents on plant varieties appropriate.) Whether the Myriad ruling leaves a door open to further challenge how patents are applied to seed remains to be seen. Justice Elena Kagan's comments suggest it does. "Our holding today is limited – addressing the situation before us, rather than every one involving a self-replicating product," she wrote. "We recognize that such inventions are becoming ever more prevalent, complex and diverse."

The second case, Bowman v. Monsanto, reflected that complexity. In this case the Supreme Court ruled that "patent exhaustion does not permit a farmer to reproduce patented seed through planting and harvesting without the patent holder's permission."[29] Beyond trying to save money, this farmer was challenging the relatively new paradigm of allowing utility patents on living organisms. In a third case, the Organic Seed Growers and Trade Association sued Monsanto challenging some of its patents on GE seed. The court effectively sided with Monsanto by dismissing the case.

To be sure, utility patents are the wrong protection for seed innovations (and other lifeforms, for that matter). The misuse of patents, especially on naturally occurring traits, must be confronted. The trend of patenting traits that also occur in nature is a growing threat to the free exchange of germplasm.*

It's equally important to establish new approaches and models for plant breeders and farmers to support more decentralized breeding, production, and distribution. In 2011, OSA facilitated a working group to explore alternative models for keeping seed in the public domain. The working group, which grew out of a 2011 report recommendation, decided that for an intellectual property model to be "alternative" it must:

- Ensure open access to plant genetics to preserve and expand this invaluable resource
- Improve availability, choice, and quality of cultivars, especially cultivars appropriate for organic systems
- Support the viability of independent seed companies and individual plant breeders
- Help overcome resource constraints and enable smaller entities to compete

- Foster investments that further innovation in plant breeding, including fair compensation for plant breeding contributions
- Meet the need of participatory plant breeding projects
- Encourage information sharing and coordination
- Reverse problematic trends resulting from the patenting of plant genetics, including barriers to accessing genetics due to outright denial, cost, onerous licensing contracts, and fear of unintentional patent infringement

Soon after, Jack Kloppenburg, a sociologist at the University of Wisconsin-Madison, organized a group of plant breeders, seed companies, farmers, and NGOs to form the Open Source Seed Initiative. Inspired by the open-source software movement, OSSI aims to create a protected commons for seed. After finding it difficult to create a legally enforceable license for seed deemed "open source," the initiative decided to create a pledge that farmers and breeders can use on their seed packets to communicate their intent for these varieties to remain freely available to everyone.** OSSI has generated a lot of interest in the US and abroad, and currently lists more than 300 varieties.

NGOs, universities, and organic seed companies are also working to develop fair licenses that support the distribution of new organic varieties. These licenses don't prohibit seed saving or future research while still returning royalties to the organic plant breeding programs involved in the variety's development – helping to fill important funding gaps.

Insufficient investments in public plant breeding

Public plant breeding programs are witnessing growing interest from students, farmers, and other researchers in serving the needs of organic agriculture. Unfortunately, as funding wanes and public breeders retire, these programs are at risk of extinction, especially for some crops. Indeed, as reported in Chapter 1, the US has lost more than 30% of public plant breeders over the last 20 years. This means our infrastructure for developing new public plant varieties, and training the next generation of plant breeders, is deteriorating.

This trend is alarming. Public research should serve the public good, and fill important research gaps at the regional level for farmers and the communities they feed. In plant breeding, this often means addressing critical yet less lucrative needs that aren't a priority for private industry, such as the needs of organic agriculture. Organic farmers are especially dependent on varieties selected for, and adapted to, their organic production needs, such as varieties that tolerate important pests and diseases.

The level of market concentration in the conventional seed industry, coupled with waning support for public plant breeding programs, makes the need to increase funding for public plant breeding that addresses the organic seed needs of farmers that much more urgent. In addition to increasing funding for research programs focused on organic agriculture, such as USDA's Organic Research and Extension Initiative (OREI), funding from other agricultural research programs – especially USDA's Agriculture and Food Research Initiative (AFRI) – must prioritize the needs of organic agriculture to ensure adequate investments in organic plant breeding and other organic seed research. AFRI has seen significant growth. Between 2011 and 2015, funding for the AFRI program increased by 23% (see Figure 18). But according to USDA's own data, the percentage of AFRI funding dedicated to organic research has averaged about 0.19% annually over that same time period. Organic farmers will continue to lack access to seed most appropriate for their production systems and regions if public research dollars don't prioritize their needs.

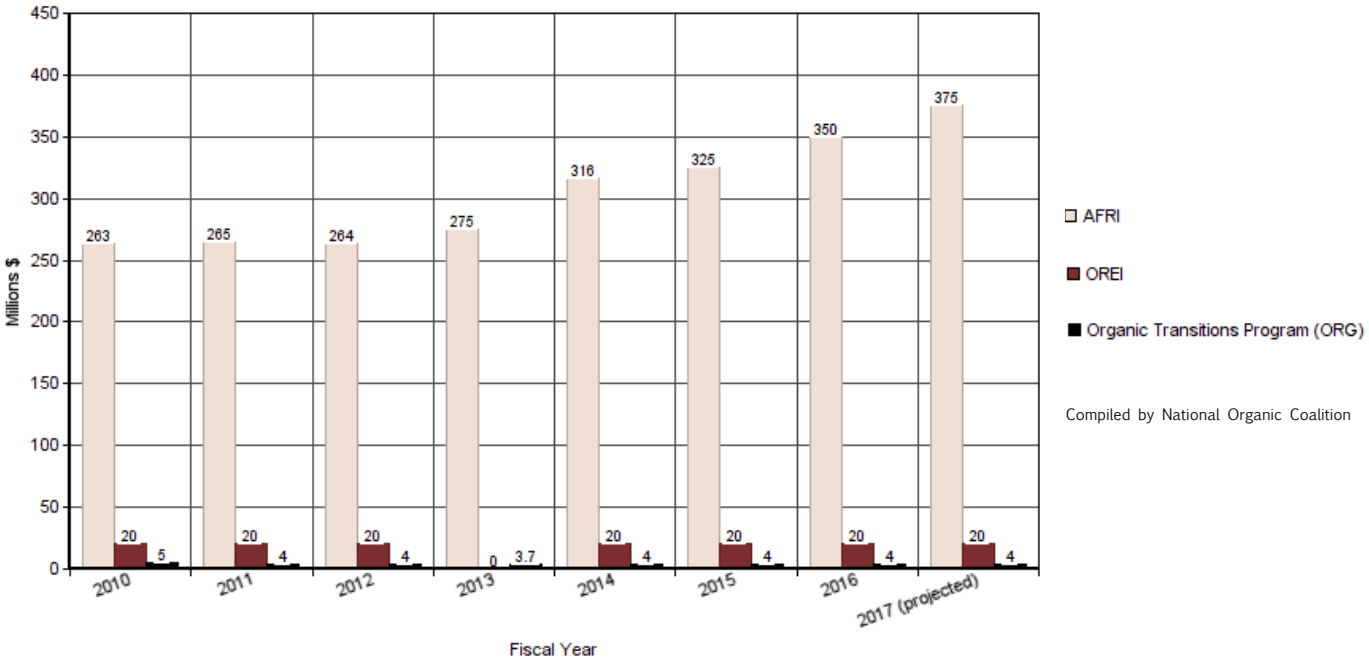
Summary

As an organic seed community, we all share the opportunity and responsibility to participate in policy efforts. Moving forward, we need more leaders and spokespeople who represent the diversity of organic seed stakeholders. We need more farmers, seed producers, plant breeders, and seed companies to join policy advocacy

* Examples of utility patents awarded for general traits that have long occurred in nature include: "red color in carrots," "heat-tolerant broccoli," "exerted broccoli head," "red lettuce," and "brilliant white cauliflower," to name a few.

** The pledge states: "You have the freedom to use these OSSI-Pledged seeds in any way you choose. In return, you pledge not to restrict others' use of these seeds or their derivatives by patents or other means, and to include this Pledge with any transfer of these seeds or their derivatives."

Figure 18. USDA competitive grant research funding trends (2010–2017)



efforts so the organic seed community can speak with a louder voice in conversations happening in the media, in the halls of the USDA, on Capitol Hill, and across the US at the local and state level.

At times certain stakeholders may feel constrained in their ability to participate in advocacy work because of concerns around formal lobbying. Yet most of the work before us is education, storytelling, and organizing a broad base of support for policies and models that are working. Just as we need diverse decision makers along the entire organic seed chain, we need diverse voices in our organic seed advocacy, too. The recommendations described below are achievable – if we're organized.

Recommendations

Improve the National Organic Program's organic seed guidance document The final guidance should be amended to include the recommendations listed on pages 50-51. Appropriate enforcement of the organic seed requirement is essential to the development of organic seed systems, as the increased sourcing of organic will have ripple effects on further investments in organic seed. We also recommend the NOP work with certifiers on a process for reviewing organic seed availability each year to determine if and when there is adequate diversity and volume to require the use of organic seed for particular crop types. This data could come from, or support, a more robust organic seed database.

Increase certifier and inspector trainings in organic seed Stronger guidance must be coupled with regular trainings for certifiers and inspectors on organic seed. For example, certifiers should be trained on availability issues as they pertain to specific crop types, regions, and scale. Certifiers and inspectors will be better equipped to evaluate the adequacy of organic seed sourcing efforts. The NOP and certification community should regularly communicate the importance of organic seed to the integrity of the organic label.

Fund and promote a national organic seed database A database that provides a comprehensive list of organic seed available in the marketplace is still lacking despite significant efforts to make Organic Seed Finder a success since our last report. Barriers keeping organic seed suppliers from participating in a database must be addressed to establish a functional and well-populated database. This database should operate on a sustainable funding model that allows for its long-term success, ideally with NOP support.

Strengthen GE crop regulations The USDA is working to update its biotechnology regulations under the

Plant Protection Act. These changes must improve oversight of experimental GE crop trials; require mandatory contamination prevention on the part of users, manufacturers, and patent owners; establish a fair compensation mechanism for losses that is paid for by patent owners; include independent environmental, health, economic, and social assessments of new GE crops; and create post-market monitoring, among other critical components that are currently absent from the current framework. The Environmental Protection Agency and Food and Drug Administration should also update their policies and regulations to address modern biotechnology and the potential risks to organic agriculture. This includes mandatory labeling for GMO ingredients and rigorous reviews of pesticides.

Address the recommendations of the Advisory Committee on Biotechnology for 21st Century Agriculture and National Genetic Resources Advisory Council While the AC21's report to the US Secretary of Agriculture failed to provide acceptable ideas for fostering "coexistence" between different farming systems, the recommendations did include useful proposals on research and seed quality, including collecting comprehensive data on contamination in the organic and non-GE seed supply and ensuring an adequate diversity of seed options in the commercial marketplace. The USDA should establish a system to examine the extent of contamination at the seed level. The USDA should also move quickly to implement the recommendations of NGRAC, which include proposals for protecting seed diversity, integrity, and market choice.

Examine the effect of the Bayh-Dole Act on public seed research The Bayh-Dole Act should be evaluated in the context of publicly funded plant breeding and other seed research. These findings should inform changes to the law, as well as changes to policies associated with intellectual property rights at universities and federal agencies administering research grants.

Support the National Organic Standards Board in addressing GE contamination The NOSB should use its advisory role to the USDA to communicate that stronger regulations are urgently needed to ensure that manufacturers, patent owners, and users of GE crops share the responsibility of preventing contamination of organic seed. The NOSB should continue working with organic seed suppliers and other stakeholders to determine the feasibility of establishing a seed purity standard. It's important that any seed purity standard be coupled with a fair compensation mechanism that's paid for by patent owners.

Support the National Organic Standards Board in addressing excluded methods New technologies have outpaced the current regulatory definition for excluded methods in the organic standards. The NOSB is making progress in clarifying principles, criteria, and definitions that will guide current and future decisions on excluded methods. This framework will help the organic community determine whether seed developed using certain methods should be allowed in organic production. The science and broader discussion are complex, given the potential risks and benefits associated with various methods.

The DOJ and USDA must block anticompetitive mergers in the seed industry The seed industry is one of the most concentrated sectors in agriculture. The largest players continue to merge, with four of the top six companies discussing mergers at the time of this writing. An extensive investigation into the impacts of the current structure – and, more urgently, into these two proposed mega-mergers – is desperately needed. Any seed market investigation must consider the interface of laws governing antitrust and intellectual property rights (IPR) to address any evidence that IPRs are being used to unfairly maintain market power. The public should be invited to participate in the review of mega-mergers through a comment period and regional hearings, since seed consolidation at this scale has tremendous impacts on farmer choice, the price of seed, and on independent seed businesses. State attorneys generals should also investigate the impacts of these mergers.

Utility patents on plant genetics must be confronted Utility patents, especially when coupled with restrictive licensing agreements, can be enforced in a manner that prohibits public research, safety and performance assessments, and a farmer's ability to save seed. Utility patents shouldn't be awarded for seed and plants. The Plant Variety Protection Act is an appropriate tool for developers to own marketing rights of sexually reproducing plants, but only when used as the

law intended: allowing researchers to further innovate with protected varieties and allowing farmers to save seed for on-farm use.

Promote appropriate intellectual property rights models for organic plant breeding Intellectual property rights models that adhere to the principles of fairness, diversity, and shared benefits should be promoted, especially at our land grant universities. Models will differ by breeding program and goals, and maybe by crop type. Breeders should communicate openly and regularly with technology transfer offices about problems and solutions regarding the exchange of seed.

Increase funding for public programs that support organic plant breeding and other organic seed research USDA's Organic Research and Extension Initiative (OREI) is the most critical funding source for organic plant breeding and other organic seed research. The funding has remained stagnant over the years. Congress should significantly increase OREI funding to meet the growing and urgent demand for organic plant breeding and organic seed research. Congress should also increase USDA's Sustainable Agriculture and Research Education (SARE) program to its intended level of funding ($60 million). Finally, USDA's Agriculture and Food Research Initiative (AFRI) is intended to address all sectors of agriculture, including organic. In addition to funding more organic plant breeding projects, the department should create a distinct funding stream for public cultivar development to more broadly support public plant breeding programs in the US that are at risk of extinction.

Direct more funding toward organic seed advocacy The organic community's capacity to organize around policy issues that advance organic seed as a solution to the challenges we face in agriculture – including changing climates and toxic pesticides in our environment – is insufficient. This is in part because foundations and other philanthropists don't fund the priorities discussed in this chapter. This fact must be viewed as a major barrier to increasing the availability, quality, and integrity of organic seed – and to achieving our broader goal of transforming how we farm and what we eat to ensure a healthier people and planet.

Conclusion and Recommendations

The recommendations from each of the three chapters are summarized below to serve as a roadmap for building organic seed systems over the next five years. (More details for each recommendation are included in the individual chapters.) We hope these recommendations guide conversations and actions moving forward, and help stakeholders identify their role in this critical work. We need all stakeholders – organic farmers, organic seed producers, organic certifiers, policy advocates, plant breeders, organic seed and food companies, and others – to help implement this roadmap. No single stakeholder group can address the diverse seed needs of organic farmers alone. When actions are guided by a shared vision and roadmap, the progress is faster, more coordinated, and longer lasting.

In this way, the *State of Organic Seed* project is a collaborative one. Just as a healthy agricultural system relies on biological diversity, this work requires a diversity of opinion, experience, and interests. Together we can grow a healthier future beginning with organic seed.

» *Organic plant breeding*

Increase public and private investments in organic plant breeding and other organic seed research While investments in organic breeding are on the rise, including investments from diverse funding sources, they are still insufficient for supporting more rapid increases in the diversity and quantity of organic seed available.

Expand the infrastructure of public and private organic plant breeding programs Breeders say they have limited access to appropriate certified organic acreage, winter nurseries, and greenhouses to conduct variety trials and organic breeding work.

Prioritize successful models and approaches to organic plant breeding Organic plant breeding requires different approaches because the production systems are different from conventional systems, as are the values, principles, and regulations associated with organic agriculture.

Develop new, and expand existing, organic variety trials at the regional and national level Variety trials provide essential performance data to farmers and researchers but many need more coordination in management, evaluation, and the dissemination of results.

Improve access to GMO-free breeding material for at-risk crops Breeders need access to more breeding lines for major crops, especially corn, that are appropriate for organic seed production.

Improve commercialization pipelines Mechanisms are needed to help new organic varieties get into the hands of farmers, including better networking between breeders and seed companies, coordination of testing networks, and streamlined intellectual property and royalty negotiations.

» *Organic seed supply*

Train more organic seed producers and support existing producers There is an urgent need to provide more formal training and resources to increase the number of organic seed producers in a variety of crops and at different scales.

Develop region-specific resources on production data and practices Organic seed producers need yield and economic data by crop type and region, as well as resources on organic seed pest and disease management, to support their success.

Create regional and national organic seed producer networks Organic seed producers are challenged by a lack of access to appropriate seed harvesting and cleaning equipment, and need more support with handling and storage.

Develop contracts that share the risks of organic seed production Seed production contracts often place risks on seed producers without premium payment or assurances from seed companies.

Protect farmers from the economic risks inherent to organic seed production Explore subsidy or other incentive programs to encourage farmers to integrate seed production into their organic farm plans.

Develop quality assurance programs Organic seed producers need better access to testing for germination and other quality characteristics, including genetically engineered content. Some seed enterprises need help developing quality assurance programs.

Develop and improve organic stock seed programs High-quality stock seed is critical for supporting the success of the commercial organic seed sector.

Create a public education campaign to promote organic seed Many organic seed stakeholders want to see an educational campaign directed at farmers, gardeners, and consumers about the benefits of organic seed, what goes into its development, and why it often has a higher price tag.

Work with organic food companies that contract specific varieties This would include identifying major gaps in varieties (or insufficient quantities of specific organic varieties) and developing a feedback loop for organic food processors and other handlers to communicate these needs to organic seed companies so the varieties can be grown organically and in sufficient quantity.

» *Organic seed policy*

Improve the National Organic Program's organic seed guidance document The final guidance should be amended to include the recommendations listed on pages 50-51.

Increase certifier and inspector trainings in organic seed Stronger guidance must be coupled with regular trainings for certifiers and inspectors in organic seed.

Establish a review of organic seed availability The National Organic Program should work with certifiers and seed suppliers on a process for reviewing organic seed availability each year to determine if and when there is adequate diversity and volume to require the use of organic seed for particular crop types. This data could come from, or support, a more robust organic seed database.

Fund and promote a national organic seed database The barriers keeping organic seed suppliers from participating in a database like Organic Seed Finder must be addressed to establish a comprehensive list of organic seed available.

Strengthen regulations governing genetically engineered crops Improvements must include better oversight of experimental trials; mandatory contamination prevention measures on the part of users, manufacturers, and patent owners; and a fair compensation mechanism for losses, among other improvements.

Address the recommendations of USDA's biotechnology and genetic resource advisory groups The USDA should collect comprehensive data on the organic and non-GE seed supply to ensure an adequate diversity of choice, and establish a system to examine the extent of contamination at the seed level.

Examine the effect of the Bayh-Dole Act on public seed research The Bayh-Dole Act should be evaluated in the context of publicly funded seed research to inform policies on how plant genetic resources are shared and protected at our land grant universities.

Support the National Organic Standards Board in addressing seed purity and excluded methods The NOSB should continue working with organic stakeholders to determine the feasibility of establishing a seed purity standard and to finalize an excluded methods proposal that clarifies the principles, criteria, and definitions that will guide current and future decisions on methods used in plant breeding.

Address problems of market concentration The Department of Justice should investigate the broad impacts of the current seed industry structure, including two proposed mergers between some of the largest players, and engage the public in its review process.

Confront utility patents on plant genetics Utility patents, especially when coupled with restrictive licensing agreements, can be enforced in a manner that prohibits public research, safety and performance assessments, and a farmer's ability to save seed.

Promote appropriate intellectual property rights models for organic plant breeding Models that adhere to the principles of fairness, diversity, and shared benefits should be promoted, especially for publicly funded research.

Direct more funding toward organic seed advocacy Organic seed policy work is lacking in part because foundations and other philanthropists don't fund the priorities discussed in this report – this is a risk point to the goal of establishing an organic food system built on a foundation of organic seed.

References

1. Organic Trade Association. 2015. "U.S. consumers across the country devour record amount of organic in 2014," April 15, accessed at https://www.ota.com/news/press-releases/18061.
2. du Toit, L.J. 2007. "Crop Profile for Cabbage Seed in Washington," USDA Pest Management Centers, accessed at http://www.ipmcenters.org/cropprofiles/docs/WAcabbageseed2007.pdf.
3. USDA-NIFA. Current Research Information System, accessed at http://cris.nifa.usda.gov/.
4. Carter, T., William F. Tracy, Thomas R. Sinclair, Thomas G. Isleib, and Richard Joost. 2014. "What is the state of public cultivar development?" Proceedings from the 2014 Summit on Seeds & Breeds for 21st Century Agriculture, accessed at http://rafiusa.org/programs/just-foods/2014-seeds-breeds-summit/.
5. Personal communication. 2016. Adrienne Shelton and Bill Tracy, March 11.
6. Food & Water Watch. 2012. "Public Research, Private Gain," accessed at http://www.foodandwaterwatch.org/insight/public-research-private-gain.
7. Ibid.
8. Editors. 2009. "Do Seed Companies Control GM Crop Research?" *Scientific American*, August 1.
9. Sampat, Bhaven N. 2010. "Lessons from Bayh-Dole," *Nature*, September 12.
10. Ibid.
11. Murphy, Kevin, et al. 2007. Evidence of varietal adaptation to organic farming systems, *Field Crops Research* 102: 172-177.
12. Simon, P.W., Zystro, J, Roberts, P.A., Waters, T., Colquhoun, J., Navazio, J., Colley, M., McCluskey, C., Hoagland, L., duToit, L., Silva, E., and Nunez, J. 2015. The CIOA (Carrot Improvement for Organic Agriculture) Project: Location, cropping system, and genetic background influence carrot performance including top height and flavor. Acta Hort.
13. USDA-NASS. 2012 Census of Agriculture, 2014 Organic Survey – Certified and Exempt Organic Farm Data, accessed at https://www.agcensus.usda.gov/Publications/Organic_Survey/.
14. 7 CFR 205.204: Seeds and planting stock practice standard.
15. National Organic Program. 2013. "Guidance on Seeds, Annual Seedlings, and Planting Stock in Organic Crop Production," March 4.
16. Organic Trade Association. 2011. Comments on the National Organic Program's draft guidance, "Seeds, Annual Seedlings, and Planting Stock in Organic Crop Production (NOP 5029)."
17. USDA-ERS. 2015. "Adoption of genetically engineered crops in the US," accessed at http://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us.aspx.
18. USDA-NASS. 2012 Census of Agriculture, 2014 OS - Certified and Exempt Organic Farm Data. See Table 19: Value of Organic Crops Loss from Presence of Genetically Modified Organisms (GMOs) – Certified and Exempt Organic Farms: 2014 and Earlier Years, pp. 199-200.
19. Benbrook, Charles M. 2012. "Impacts of genetically engineered crops on pesticide use in the U.S. – the first sixteen years," *Environmental Sciences Europe*, September 28.
20. Ibid.
21. National Organic Program. 2013. "Cell Fusion Techniques Used in Seed Production," Policy Memo 13-1, February 1.
22. Personal communication. 2013. Philip H. Howard, September.
23. Matson, James, M. Tang, and S. Wynn. 2012. "Intellectual Property and Market Power in the Seed Industry: The Shifting Foundation of Our Food System," University of Wisconsin Law School Government and Legislative Clinic, September 1.
24. Ibid.
25. Hubbard, K. 2009. *Out of Hand: Farmers Face the Consequences of a Consolidated Seed Industry*, National Family Farm Coalition, accessed at www.farmertofarmercampaign.org.
26. Pardey, Philip, B. Koo, J. Drew, J. Horwich, and C. Nottenburg. 2013. "The evolving landscape of plant varietal rights in the United States, 1930 – 2008," *Nature Biotechnology*, January.
27. Fernandez-Cornejo, Jorge and D. Schimmelpfennig. 2004. AmberWaves, "Have Seed Industry Changes Affected Research Effort?" USDA/ERS, February.
28. *Association for Molecular Pathology v. Myriad Genetics*, No. 12-398 (U.S. June 13, 2013).
29. *Bowman v. Monsanto Company*, No. 11-796 (U.S. May 13, 2013).

Appendix A

Appendix A.1: Organic seed research investment methods

To locate public organic seed and breeding initiatives, we examined lists and databases of the following programs and foundations: the USDA Organic Research and Education Initiative (began as IOP and became OREI), USDA Agriculture and Food Research Initiative (AFRI), the USDA Sustainable Research and Education program (SARE), the federal Risk Management Agency (RMA), the USDA Value Added Producer Grants program (VAPG), and federal and state Specialty Crop Grants. Additionally, we searched the USDA Current Research Information System (CRIS) for projects outside of the above listed programs. We also searched the funding records of the following foundations, trusts, and funds: the Organic Farming Research Foundation (OFRF), the Farmers Assisting Farmers Fund (FAFO), Ceres Trust, Seed Matters Initiative (Clif Bar Family Foundation), Columbia Foundation, and Gaia Fund.

Search terms included "organic" combined with "trial," "breed," "seed," "variety," "cultivar," or "germplasm."

Project funding was divided in six ways: by year, by funding source, by project type, by crop type, by region, and by project budget. When calculating funding for multi-year projects, we considered total funding to be evenly distributed into all of the years in the project's term. Funding sources were divided into six categories: USDA-OREI, SARE, other federal funds, CERES Trust, Clif Bar Family Foundation, FAFO, OFRF, and other Non-Federal Funds. The projects were split by topic into breeding/ variety trials, enterprise development, seed production research and education, policy and systems development, and multi-topic. Projects were also split into eight regional categories: Midwest, Northeast, Northern Plains, Pacific Northwest, Southeast, Southern Plains, Southwest, and multi-region. Projects were divided by crop type into corn, legumes, potato, vegetables, wheat, multiple field crops, multiple small grains, multiple, and other. Some projects that involved wheat were included in the multiple small grains category, and some projects that involved corn were included in the multiple field crops. Finally, project were divided into categories based on total project budget as follows: less than $5,000, $5,000 - $10,000, $10,000 - $50,000, $50,000 - $100,000, and more than $100,000.

Appendix A.2: Organic seed research projects

PROJECT NAME	RECIPIENT ORGANIZATION	YEAR(S)	SOURCE	FUNDING AMOUNT
Breeding / Variety Trials				
Barley and Alternative Crop Breeding Program in Washington State	Washington State University	2012 - 2017	Clif Bar Family Foundation	$125,000
Breeding Day-Neutral Strawberry Cultivars for Organic Production in the Pacific Northwest	Washington State University - Puyallup	2012	OFRF	$11,200
Breeding New Organic Oat and Wheat Varieties to Enhance Economic and Environmental Performance in Western Washington	Washington State University	2013 - 2018	Clif Bar Family Foundation	$125,000
Breeding Organic Corn Varieties to Resist GMO Contamination	University of Tennessee	2012 - 2014	SARE	$48,153
Breeding Sweet Corn for Organic Farming Systems	University of Wisconsin - Madison	2012 - 2017	Clif Bar Family Foundation	$125,000
Carrot Improvement for Organic Agriculture with Added Grower and Consumer Value	Agricultural Research Service	2011 - 2015	OREI	$2,097,770
Climate Change, Mitigation, and Adaptation in Corn-Based Cropping Systems	Cropping Systems Coordinated Agricultural Project	2013	FAFO	$75,000
Creating an Organic Plant Breeding Center	North Carolina State University - Crop Science	2012 - 2015	OREI	$1,262,855
Creation of Two Open-Pollinated, Sugary Enhanced Sweet Corn Varieties	Lupine Knoll Farm	2011 - 2014	OFRF	$34,830
Developing "Organic-Ready" Maize Populations with Gametophytic Incompatibility	Dickinson Research Extension Center	2011 - 2014	OFRF	$47,200
Developing Adapted Varieties and Optimal Management Practices for Quinoa in Diverse Environments	Washington State University - Crop & Soil Sciences	2012 - 2016	OREI	$1,603,653
Developing Small Grains Cultivars and Systems Optimally Suited for Organic Production	University of Nebraska - Agronomy & Horticulture	2010 - 2012	OREI	$387,969
Developing Wheat Varieties for Organic Agricultural Systems	Washington State University - Crop & Soil Sciences	2010 - 2011	Other Federal Funds	$345,279
Development of Cultivars and IPM Strategies for Organic Cotton Production	Lubbock - TAMU Agr Res Cntr TEXAS A&M UNIVERSITY	2011 - 2015	OREI	$793,724
Evaluation of Day-Neutral Strawberries	Washington State University	2010	OFRF	$12,880
Evaluation of the Insect Resistance of Interspecific Squash Hybrids	Green Dragon Farm	2011 - 2013	SARE	$4,022
Farmer Driven Breeding: Addressing the Needs of Southeastern Organic Field Crop Producers	North Carolina State University - Crop Science	2010 - 2013	OREI	$939,954
Farmer-Based Evolutionary Participatory Plant Breeding for Organic Quinoa, Buckwheat, and Spelt	Washington State University	2010	OFRF	$14,177
Four Organic Breeding Guides: An Introduction to Organic Breeding; and Organic Breeding for Sweet Corn, Carrots, and Tomatoes	Organic Seed Alliance	2010	OFRF	$14,815
Identifying and Marketing Quality Open-Pollinated and Organic Cucurbit Seedstocks for Virginia	Twin Oaks Seed Farm	2014	SARE	$9,963
Identifying Heirloom and Specialty Varieties Resistant to Silver Scarf Disease for Organic Potato Production	University of Wisconsin - Madison	2011 - 2012	CERES Trust	$10,000
Identifying Potato Varieties with Increased Levels of Mature Plant Resistance to Potato Virus Y for Improved Organic Seed Potato Production	University of Wisconsin - Madison	2012 - 2014	CERES Trust	$10,000
Identifying Priorities and Opportunities to Advance Organic Plant Breeding in the Pacific Northwest	Organic Seed Alliance	2014 - 2015	OREI	$33,000
Improving Soybean and Dry Bean Varieties and Rhizobia for Organic Systems	University of Minnesota - Agronomy & Plant Genetics	2011 - 2014	OREI	$1,450,922
Mideast Organic Corn Variety Trial	Kentucky State University Organic Agriculture Working Group	2013 - 2014	FAFO	$50,000
New Buckwheat Varieties For Greater Sustainability	Northern Plains Sustainable Agriculture Society Farm Breeding Club	2013 - 2014	SARE	$18,881
Northern Organic Vegetable Improvement Collaborative (NOVIC)	Oregon State University	2010 - 2014	OREI	$1,923,538

Northern Organic Vegetable Improvement Collaborative (NOVIC) II	Oregon State University	2014 - 2018	OREI	$1,997,986
On-Farm Organic Soybean Variety Trials	Michigan State University Extension	2012 - 2014	SARE	$199,153
Open Source Carrots	University of Wisconsin - Madison	2014	CERES Trust	$9,981
Organic Barley Breeding	Washington State University	2012 - 2017	Clif Bar Family Foundation	$125,000
Organic Breeding for Late Blight Resistance in Tomatoes	Oregon State University	2012 - 2017	Clif Bar Family Foundation	$125,000
Organic Brussels Sprouts in The Northeast: Variety, Pest Control, and Storage Trials	Blue Heron Farm	2011 - 2013	SARE	$6,134
Organic Corn Varieties to Resist Contamination from Genetically Engineered Corn Pollen	North Carolina State University	2013 - 2018	Clif Bar Family Foundation	$125,000
Organic Cotton Breeding	Texas A&M AgriLife Research	2013 - 2018	Clif Bar Family Foundation	$125,000
Organic Crop Cultivar Selection for Great Plains States in the North Central Region	North Dakota State University	2010 - 2012	CERES Trust	$156,096
Organic Dry Bean Breeding	UC Davis	2014	Clif Bar Family Foundation	$36,000
Organic Food Barley: Developing Nutritious and Delicious Varieties for the Pacific Northwest	Washington State University	2014	OFRF	$15,000
Organic Participatory Plant Breeding Toolkit: Tools & Training in Participatory Breeding Projects for Researchers and Organic Farmers	Organic Seed Alliance	2011	OFRF	$12,021
Organic Potato Variety Trial in Michigan's Upper Peninsula	Wixtrom Natural Farms	2013	SARE	$2,246
Organic Vegetable Breeding	Oregon State University	2012	Clif Bar Family Foundation	$25,000
Participatory Development of an Open Pollinated Early Maturating Sweet Corn for Organic Production	University of Wisconsin	2013 - 2014	CERES Trust	$9,996
Participatory Screening of Broccoli Varieties for Organic Systems in Western NC	NCSU Mountain Horticultural Crops Research and Extension Center	2011 - 2014	CERES Trust	$59,147
Participatory Variety Trials for Flavor, Quality and Agronomic Performance to Increase Direct-Market Opportunities and On-Farm Trialing Capacity for Organic Growers	University of Wisconsin - Madison	2014	CERES Trust	$10,000
Plant Breeding and Agronomic Research for Organic Hop Production Systems	Washington State University - Crop & Soil Sciences	2010 - 2013	OREI	$328,062
Practical Approach to Controlling Foliar Pathogens in Organic Tomato Production Through Participatory Breeding and Integrated Pest Mgmt	Purdue University	2014 - 2018	OREI	$1,987,150
Practical Perennials: Partnering with Farmers to Develop a New Type of Wheat Crop	Michigan State University	2010 - 2013	OREI	$839,739
Quinoa Trial for Northeast Upland Farms	Maplebank Farm	2012	SARE	$9,370
Selecting For Resilience In Low-Input Potato Cropping Systems: Connecting Farmers And Breeders With The Genetic Resources Of An Underutilized Potato Germplasm Collection	University of Wisconsin - Madison	2012 - 2014	SARE	$190,512
Snap Beans with Enhanced Nitrogen-Use Efficiency for Organic Production	University of Wisconsin - Madison	2012 - 2013	OFRF	$14,224
Strengthening Public Corn Breeding to Ensure Organic Farmers' Access to Elite Cultivars	Agricultural Research Service	2010 - 2014	OREI	$2,864,478
Tasting/Networking and Seed Access for Four Key Crops	Organic Seed Alliance	2013	Other Federal Funds	$64,246
Value-Added Grains for Local and Regional Food Systems	Cornell University	2011 - 2015	OREI	$2,356,999
Washington State University Graduate Fellowship	Washington State University - Pullman	2013	Clif Bar Family Foundation	$25,000
Washington State University Graduate Fellowship	Washington State University - Mt. Vernon	2013	Clif Bar Family Foundation	$56,250
Policy and Systems Development				
Advocating for the Future of Organic Agriculture and Crop Diversity	Rural Advancement Foundation International	2013	FAFO	$30,000
Farmer Seed Stewards Program	Organic Seed Alliance	2012	Clif Bar Family Foundation	$45,000
Organic Carrots and Impact of Patents on Plant Genetic Diversity	University of Wisconsin - Madison	2013 - 2018	Clif Bar Family Foundation	$125,000
Organic Seed Alliance - Advocacy	Organic Seed Alliance	2012 - 2014	FAFO	$75,000
Organic Seed Working Groups	Organic Seed Alliance	2011	FAFO	$27,000

Planning for Organic Plant Breeding and Seed Production in the Southeast	Organic Seed Alliance	2014 - 2015	OREI	$42,951
Public Plant Breeding Survey	University of Wisconsin - Madison	2014	Clif Bar Family Foundation	$25,000
Save Seed Sharing Campaign/Richmond Grows Seed Library	Richmond Grows Seed Lending Library	2012	Clif Bar Family Foundation	$2,000
Seeds and Breeds Conference	RAFI	2014	Clif Bar Family Foundation	$40,000
The Seed We Need - Working Group, Symposium, and Action Plan for the Advancement of Organic Seed Systems	Organic Seed Alliance	2010	FAFO	$5,000
The Seed We Need - Working Group, Symposium, and Action Plan for the Advancement of Organic Seed Systems	Organic Seed Alliance	2010	OREI	$23,141
Seed Production Research and Education				
Can Organic Garlic Seed Stock be Created Disease-Free from the Production of Garlic Bulbils?	Honeyhill Farm	2013	OFRF	$8,906
Climatic Risk Management Publication and Trainings for Organic and Specialty Vegetable Seed Producers - Including Hispanic Producers	Organic Seed Alliance	2012	Other Federal Funds	$82,063
Cowpea and Forage Radish Cover Crop Seed for Northern Climates	Northern Plains Sustainable Agriculture Society	2012 - 2013	SARE	$199,776
Effect of Compost Extracts on Organic Seed Germination and Reduction of Weed Seed Expression	The Rodale Institute	2013 - 2014	OFRF	$14,376
Feasibility of Small-Scale Certified Organic Seed Production, Marketing, and Sales	Chickadee Farm	2014	Other Federal Funds	$5,000
Improving Seed Quality of Northeast-Grown Seed: Focus on Disease	Hudson Valley Seed Library	2013 - 2014	SARE	$14,940
Managing Indigenous Seed-Inhabiting Microbes for Biological Control Against Fusarium Pathogens in Corn	Oregon State University	2013	OFRF	$13,000
Optimizing Sorghum-Sudan/Forage Soybean Cover Crop Populations and Screening Sorghum Varieties for Organic Cover Crop Performance, Forage, and Seed Production in the Northern Great Plains Region	Berry Farm	2010 - 2012	SARE	$17,912
Organic Seed Production and Improvement Training Program for Vermont	North East Organic Farming Association	2013	OFRF	$9,195
Organic Seed, Soils, and Sustainable Business: Three Intensives and an Online Tutorial	Organic Seed Alliance	2010 - 2012	SARE	$76,712
Organic Seed: Increasing Regional Organic Farming Capacity Through Shared Learning Around Research, Development, Production and Marketing	Greenbank Farm	2012	Other Federal Funds	$141,000
Perceptions and Use of Organic Seed and Varieties by Midwestern Organic Vegetable Growers	University of Wisconsin - Madison	2011 - 2012	CERES Trust	$9,584
Pollinator Conservation Strategies for Organic Seed Producers	Xerces Society for Invertebrate Conservation	2012	FAFO	$15,000
The Community Seed Resource Program	Seed Savers Exchange	2013	Clif Bar Family Foundation	$51,560
Multi-Topic				
Building Resilience and Flexibility into Midwest Organic Potato Production: Participatory Breeding and Seed Potato Production	University of Wisconsin - Madison	2014 - 2016	SARE	$199,106
Development a Healthy Regional Sustainable Seed System in Northern California	Organic Seed Alliance	2013 - 2014	Other Non-Federal Funds	$60,000
Development of Sustainable Seed Systems in Northern California	Organic Seed Alliance	2010 - 2011	Other Non-Federal Funds	$23,200
Farm-Based Selection and Seed Production or Varieties of Bread Wheat, Spelt, Emmer, and Einkorn Adapted to Organic Systems in the Northeast	Cornell University	2012 - 2015	SARE	$196,743
Native Seeds/SEARCH - Creating a Robust and Healthy Food System	Native Seeds/SEARCH	2011 - 2014	Clif Bar Family Foundation	$6,000
Organic Seed Alliance	Organic Seed Alliance	2011 - 2013	Clif Bar Family Foundation	$70,610
Seed Matters	OFRF	2014	Other Non-Federal Funds	$50,000
Strengthening the Organic Seed System in California	Organic Seed Alliance	2011 - 2012	Other Non-Federal Funds	$30,000

Appendix A.3: Survey questions for principal investigators of research projects

1. What was the name of your project?

2. Please describe any successes, including tangible results, coming out of your project.

3. Please describe any obstacles you faced in meeting the goals of your project.

4. Did the project lack resources – physical, technical, or intellectual – that it could have benefited from? If so, which resources and how might the project have benefited from them?

5. Did farmers or other stakeholders (from the food, agriculture, or research communities) contribute to your project? **Yes / No**

6. If so, which stakeholders?

7. In what ways did they contribute (e.g., design, execution, evaluation, other)?

8. Was their involvement helpful? How?

9. Was their level of involvement more or less than you had anticipated? **More / Less / About what I anticipated**

10. If their involvement was different than expected, what factors do you think might have contributed to this? **Comments**

11. If your project focused on plant breeding, were any finished varieties or breeding material released as part of this project? **Yes / No**

12. If varieties or breeding material was released, describe any mechanisms that were used to protect them (e.g., PVPs, MTAs, utility patents, OSSI pledge, etc).

13. What was the largest source of funding for this project?

14. List any other sources of funding. **Comments**

15. Were you able to use earned revenue (from variety releases or otherwise) to help fund this work? **Yes / No**

16. Has this project resulted in any new organic breeding or seed projects? **Yes / No**

17. If so, please describe any new projects that have come out of this project.

Appendix B

Appendix B.1: Seed company survey questions

1. What term defines your company's geographic reach? Select ONE that best applies:

_____ Regional
_____ National
_____ International

2. Which best describes your business? Check all that apply. If more than one apply, please estimate the percent of business focused on that market.

__ We produce seed and sell wholesale to retail seed companies __%
__ We breed varieties and license them to retail seed companies for production __%
__ We sell retail to farmers __%
__ We sell retail to gardeners __%

3. What crop categories do you attempt to serve? Please rank ALL that apply to you with 1 as the most important, 2 as second most important, etc. DO NOT rank categories that you do not serve – leave these blank.

_____ Field corn (feed or processing)
_____ Soybeans
_____ Cotton
_____ Wheat and small grains
_____ Forage and/or cover crops
_____ Fresh market vegetables (includes sweet corn)
_____ Vegetables for canning and processing
_____ Potatoes, garlic or other vegetative propagules
_____ Ornamentals including annual flowers and perennials

4. Which type of seed do you work with? Please check ALL that apply. Please note that "conventional" in this case means not certified organic.

_____ Conventional un-treated seed
_____ Conventional treated seed
_____ Conventional seed with biotech traits
_____ Certified organic seed
_____ Certified biodynamic seed

5. What is the range of your gross annual seed-related revenue? Select the range that best applies.

___ Under $100,000
___ $100,000-249,999
___ $250,000-499,999
___ $500,000-999,999
___ $1 million-2.5 million
___ Over $2.5 million

6. Based on gross annual sales, please list the approximate percentage of your seed sourcing using the following categories (all categories should add up to 100%).

___ Self-produced
___ Produced under contract
___ Purchased wholesale
___ Other (fill in): _____

7. Over the past 5 years, how has your gross revenue changed? Select the range that best applies.

___ Increased over 20% year over year
___ Increased 6-20% year over year
___ Increased 1-5% year over year
___ Remained close to constant (between -1% and 1% change year over year)
___ Decreased 1-5% year over year
___ Decreased 6% or more year over year

8. What do you see as the major barriers to growth for your business?

9. What percentage of your gross annual seed-related revenue is from certified organic seed products? Please indicate percentage 0-100. _____

10. Over the past 5 years, how has percentage of gross annual seed-related revenue from certified organic seed products changed? Select the range that best applies.

___ Increased over 20% year over year
___ Increased 6-20% year over year
___ Increased 1-5% year over year
___ Remained close to constant (between -1% and 1% change year over year)
___ Decreased 1-5% year over year
___ Decreased 6% or more year over year

11. What do you see as the major barriers to increasing organic seed sales as part of your business?

12. What have been the greatest production challenges for your business?

13. What are some examples of solutions or successes relating to production?

14. What have been the greatest economic challenges for your business?

15. What are some examples of solutions or successes relating to economics?

16. What have been the greatest policy or legal challenges for your business?

17. What are some examples of solutions or successes relating to policy or law?

18. What are the highest priority actions or projects that the organic seed community (private companies, universities, non-profits) should collectively undertake to build the organic seed industry over the next five years?

19. What are the highest priority actions or projects that you believe Organic Seed Alliance should undertake over the next five years to support the organic seed industry?

20. Do you believe Organic Seed Finder is a valuable resource for the organic community?

21. If you participate in Organic Seed Finder, are there aspects of the website that can be improved? If yes, please explain.

22. If you are not participating in Organic Seed Finder, please explain why.

23. Any additional comments or feedback about Organic Seed Finder?

Appendix C

Appendix C.1: Certifier survey questions

1. Organic seed is gaining acceptance in the market.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

2. Stronger organic seed regulations are not needed at this time.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

3. Most organic growers make a greater effort to find organic seed than simply referring to three catalogs/sources.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

4. It is feasible for Accredited Certifying Agents (ACAs) to collect sufficient data from their clients to evaluate the commercial availability of organic seed.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

5. It is feasible for ACAs to evaluate equivalent varieties when their clients claimed they were unable to source organic seed.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

6. Additional educational materials and outreach for organic farmers, such as access to organic variety trial data, would increase usage of organic seed.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

7. The NOP's guidance document, "Seeds, Annual Seedlings, and Planting Stock in Organic Crop Production," published in March of 2013, makes it easier for ACAs to determine when seed can be categorized as commercially unavailable.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

8. Inspectors and certification reviewers need additional training to understand seed issues from the farmer perspective.
___ Strongly disagree
___ Disagree
___ Neutral
___ Agree
___ Strongly agree
___ Not sure
Comments:

9. To the best of your knowledge, please list any trends in exemptions for organic VEGETABLE CROP seed for the past three years. (For example, if you have noticed frequent exemptions for a particular crop type,such as sweet corn, list that here. These trends, if only anecdotal, help us understand gaps in organic seed availability.)
Comments:

10. To the best of your knowledge, for the past three years, the demand for exemptions for organic VEGETABLE seed has:
___ Increased
___ Stayed the same
___ Decreased

11. To the best of your knowledge, please list any trends in exemptions for organic FIELD CROP seed for the past three years:
Comments:

12. To the best of your knowledge, for the past three years, the demand for exemptions for organic FIELD CROP seed has:
___ Increased
___ Stayed the same
___ Decreased

13. Please share what you believe are the most common reasons your clients ask for an exemption on organic seed for VEGETABLE crops.
Not a factor/ Slight factor / Moderate factor / More than moderate factor / Significant factor
___ Specific variety not available in a certified organic form
___ Insufficient quantity of seed
___ Processor (buyer) demands varieties in contract that are not available organically
___ Save their own seed
___ Distrust of organic seed quality
___ Seed sizing
___ Lack of seed treatments, such as pelleting or priming
___ Lack of desirable genetic traits
___ Price is too high
Please specify any additional reasons and rate their significance.

14. Please share what you believe are the most common reasons your clients ask for an exemption on organic seed for FIELD CROPS.
Not a factor / Slight factor / Moderate factor / More than moderate factor / Significant factor
___ Specific variety not available in a certified organic form
___ Insufficient quantity of seed
___ Processor (buyer) demands varieties in contract that are not available organically
___ Save their own seed
___ Distrust of organic seed quality
___ Seed sizing
___ Lack of seed treatments, such as pelleting or priming
___ Lack of desirable genetic traits
___ Price is too high
Please specify any additional reasons and rate their significance.

15. Have you encountered a situation where an organic seed exemption was requested but denied?
___ Yes
___ No
If you answered yes, do you know the reason for the denial? Please specify here:

16. If you have noticed other trends or if you have any other insight to offer on the issue of organic seed exemptions, please explain here:
Comments:

17. Do your inspectors ever physically inspect seed labels and match them to the seed lot invoices during your review process?
___ Yes
___ No
Comments:

18. Do your inspectors ever physically inspect seed?
___ Yes
___ No
Comments:

19. In your experience, is visual inspection of seed adequate to determine if a coating or treatment has been applied?
___ Yes
___ No
Comments:

20. Do you conduct random reviews of seed invoices of your clients to ensure seed approved is actual seed purchased?
___ Yes
___ No
___ Other:

21. Have you strengthened your policies and procedures regarding organic seed over the last three years? If yes, please mark all relevant options below and/or explain under "other" below.
___ No, we haven't strengthened our policies and procedures regarding organic seed
___ Yes, we have required operations we certify to (please check all options below that apply):
___ Conduct trials of available organic varieties
___ Search the Organic Seed Finder website
___ Research more than three seed catalogues
___ Request seed in a timely manner
___ Contract organic seed production
___ Other (please specify below)

22. If you were to recommend resources to certified operations for identifying organic seed availability, where would you point them? (Check all that apply.)
___ Organic Seed Finder
___ FarmsReach seed sourcing tool
___ PickACarrot.org
___ NCAT/ATTRA organic seed listings

23. May we contact you with follow-up questions? If so, please provide your contact information below. (Your information will not be shared or added to email lists.)
Name
Company
Email Address
Phone Number

Appendix D

Appendix D.1: Farmer survey methods

The survey questions were designed to get information in four areas: (1) farm demographics of respondents; (2) usage of organic seed; (3) challenges in using organic seed; and (4) the need/potential for organic seed.

In creating the survey we received input from representatives from organic certification agencies, nonprofits, farmer associations, individual producers, and the seed and food industries. We conducted a test run of the survey with 20 farmers and incorporated their comments and feedback into the final.

We restricted the number of questions to keep the time spent by each respondent relatively short. Our goal was to have the average response time be 15 minutes or less. If we exclude the 55 respondents who took over two hours (assuming that they left the survey open but were not actively working on it) the actual average response time was 14 minutes.

Surveys were disseminated electronically via SurveyMonkey, an online survey tool, and when necessary in paper format, through OSA's email list, certification agencies, state and regional farm associations, and cooperatives throughout the US (see Table 1 below).

Table 1. Organizations that distributed the organic farmer seed survey and received at least one response.

California Certified Organic Farmers	New Hampshire Department of Agriculture
Carolina Farm Stewardship Association	Northeast Organic Farming Association (NOFA)
Department of Plant and Industry, Clemson University	Organic Farmers' Agency for Relationship Marketing (OFARM)
Ecocert ICO, LLC	Ohio Ecological Food and Farm Association
Ecological Farming Association	Oregon Department of Agriculture
Georgia Organic	Oregon Tilth
Horizon Organic	Organic Farming Research Foundation
International Certification Services, Inc.	Organically Grown Company
International Organic Inspectors Association	Organic Seed Alliance
Midwest Organic and Sustainable Education Service	Pennsylvania Association for Sustainable Agriculture
Midwest Organic Farmers Cooperative	Practical Farmers of Iowa
Midwest Organic Services Association	Quality Certification Services
Montana Department of Agriculture	Rural Advancement Foundation International
Monterey County Certified Organics	Tilth Producers of Washington
National Organic Coalition	Vermont Organic Farmers
Nevada Department of Agriculture	

In addition to distributing the survey through partners, we also contacted a random sample of 800 producers selected from the National Organic Program's list of certified operations. We included a random sample in our analysis because we wanted to make sure that the responding producers on OSA's and our partners' lists had similar demographics and opinions as the broader population of organic producers. In our sample group we made an effort to get a high response rate to ensure that we didn't just hear from only the most passionate organic producers in our sample group. In addition to emailing them the initial survey request, we sent three follow-up emails, mailed paper copies of the survey, and made individual phone calls.

The survey was open from June through December of 2014. During that time we received distinct responses from 1,365 certified organic farmers. According to USDA's 2014 Organic Production Survey there are 12,595 certified organic farms in the US. This includes farms that likely don't use seed (all of their production is in fruit, livestock, or other) and as such the number of certified organic farms using seed is under 12,000. Therefore we feel comfortable in claiming a response rate of 10% of the certified organic farms in the country. We received responses from 203 out of the 800 producers in our random sample, providing a response rate of 25% within our sample group.

The summary of data in this report is generally based on averages from all respondents. We analyzed the results from the random sample group and found no significant differences in responses between the 203 respondents in the random sample group and the 1,365 respondents in the entire group.

Where possible, we included both results from the 2009 and 2014 surveys. Not all questions could be compared, however, because we didn't include the question in one of the two surveys or because we asked the question in a different way.

The confidence intervals (error bars) in the results report the range that the true result would be expected to be in 95% of the time. In general, when there are fewer responses included in an average or percentage, the error is greater. This would happen either when we had fewer overall responses to a question or when we divided the responses into many categories with relatively few respondents in each category. The error can also be large when respondents provided very different answers from one another. The error bars can be used to determine how likely it is that the averages or percentages differ from one another; for example, the responses from 2009 and 2014, or the responses from large and small vegetable producers. If the error bars overlap, then we can't be sure the averages or percentages are actually different.

When asking farmers for their "top 3" crops by acreage, we allowed them to write in a response. Some growers responded generally – "greens" and "tomatoes" – whereas others were specific, such as "Romaine lettuce," "collards," and "paste tomatoes." For the purpose of the summary within this report, we grouped responses into generalizations.

Appendix D

Appendix D.2: Farmer survey data

Figure 1. How many years have you been certified organic?

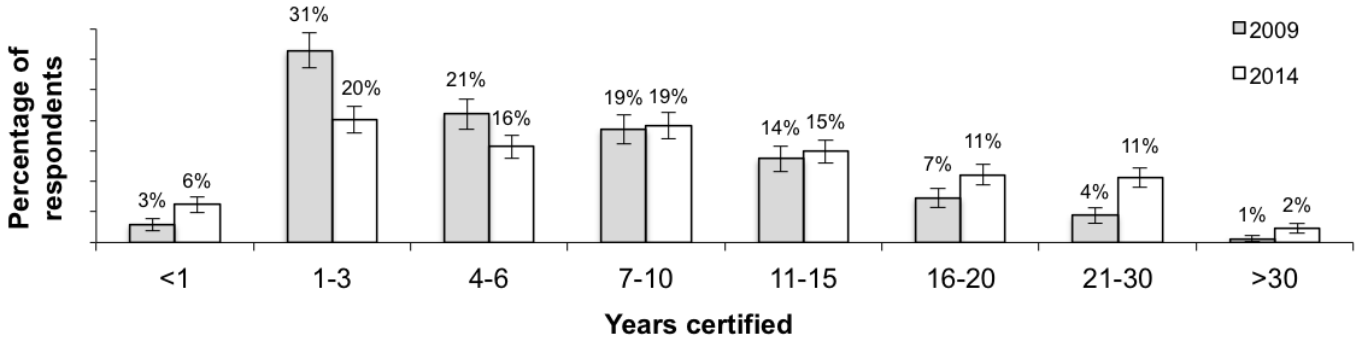


Figure 2. Respondent locations.

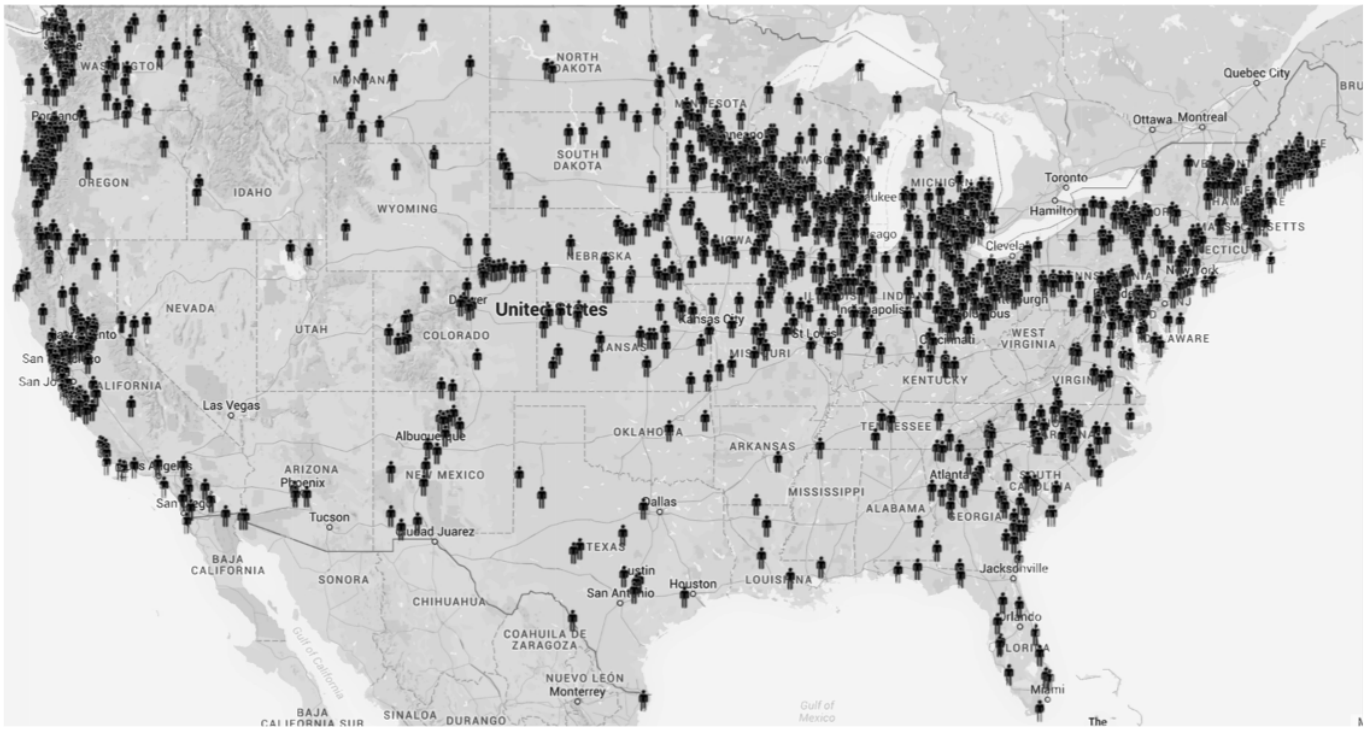


Figure 3. Did you have any organic acres in annual vegetables last year?

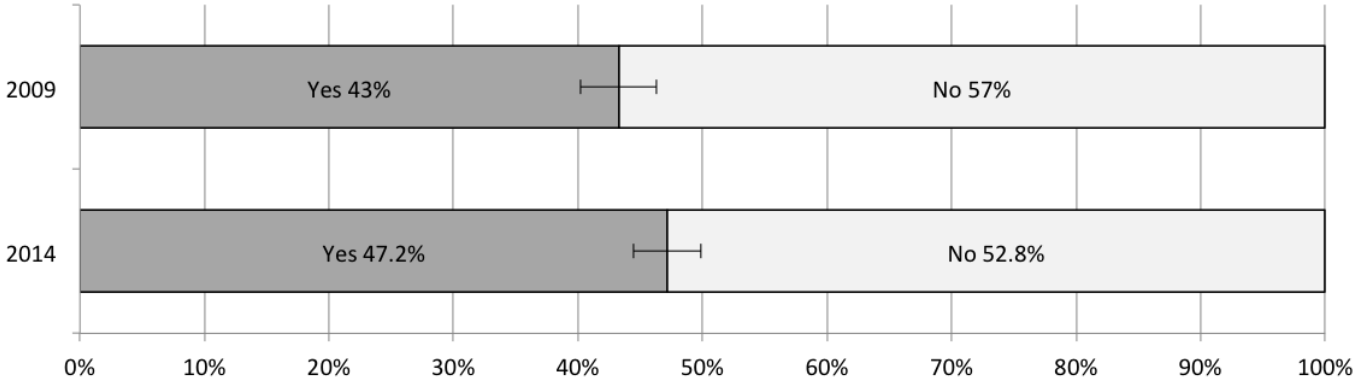


Figure 4. How many organic acres did you have in annual vegetables last year?

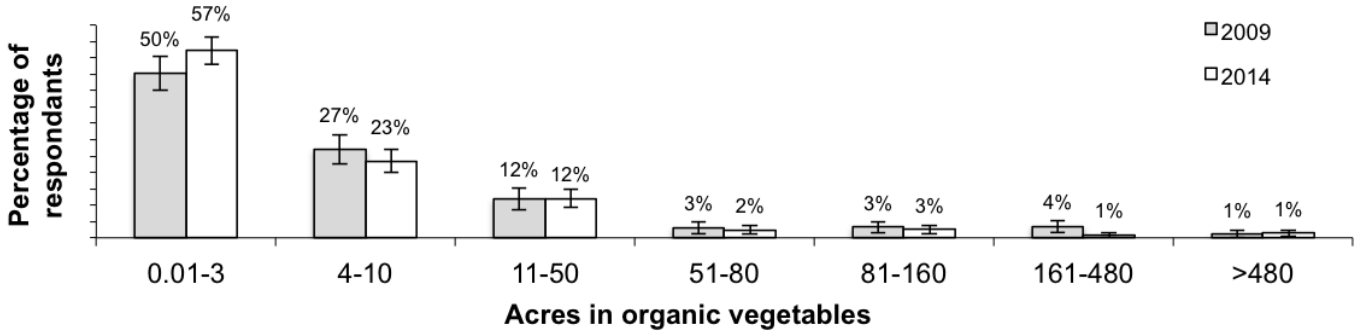


Figure 5. What approximate percentage of total acreage of annual vegetables was planted with certified organic seed last year?

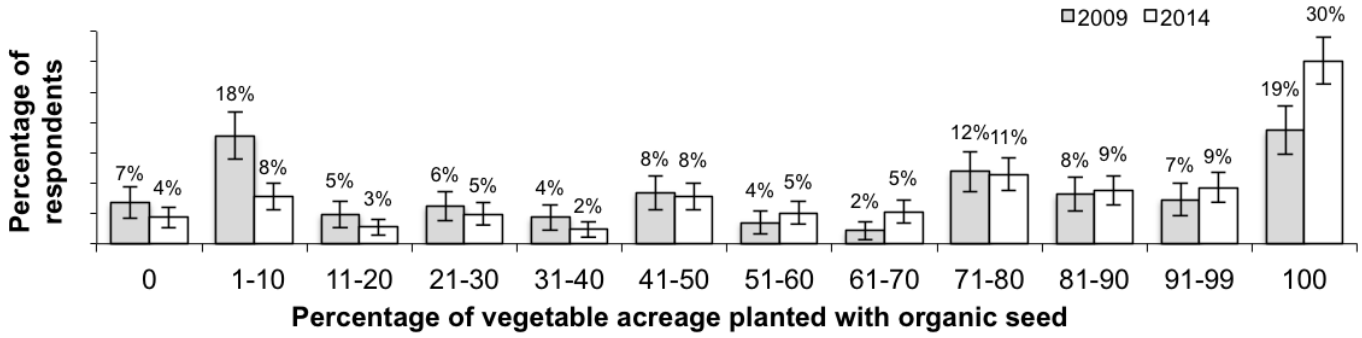


Figure 6. Average percent vegetable acreage planted to organic seed.

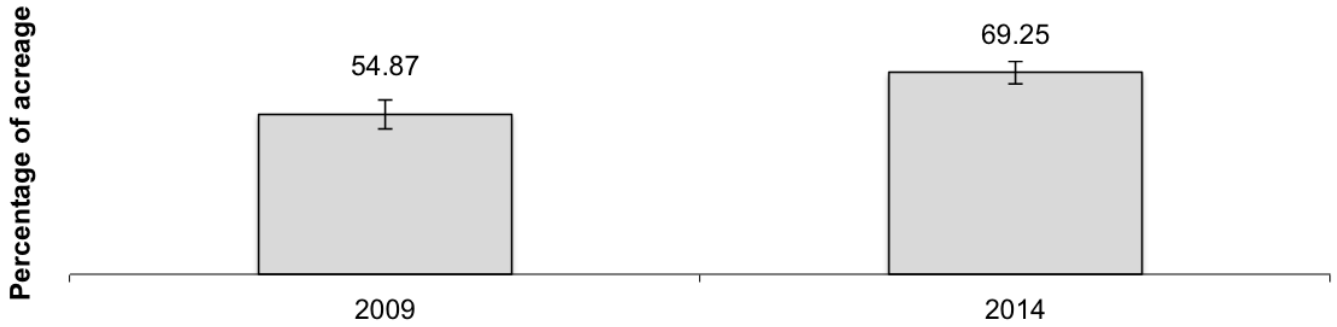


Figure 7. Percent organic seed used for TOMATOES — the #1 vegetable category.

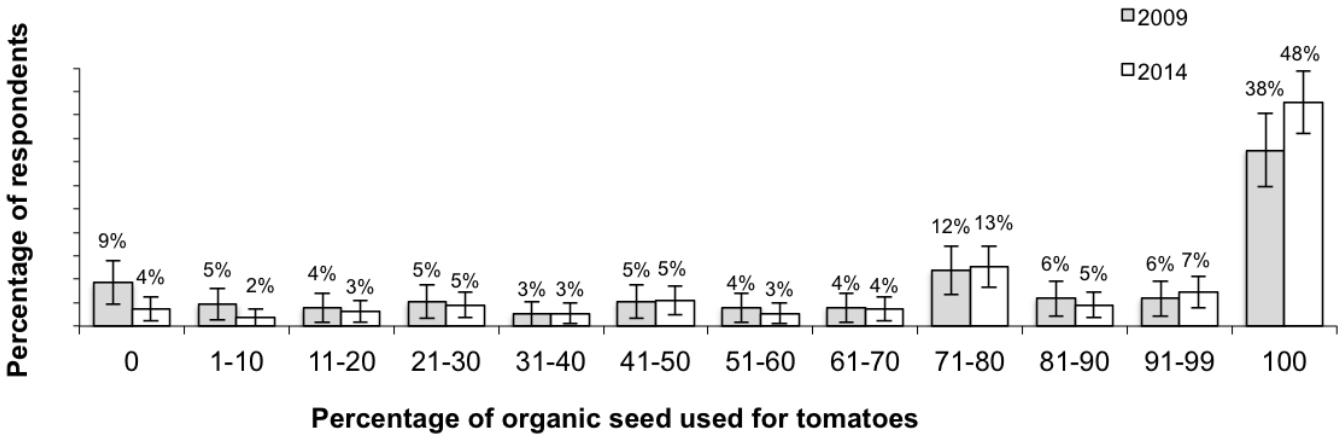


Figure 8. Percent organic seed used for LETTUCE/GREENS — the #2 vegetable category.

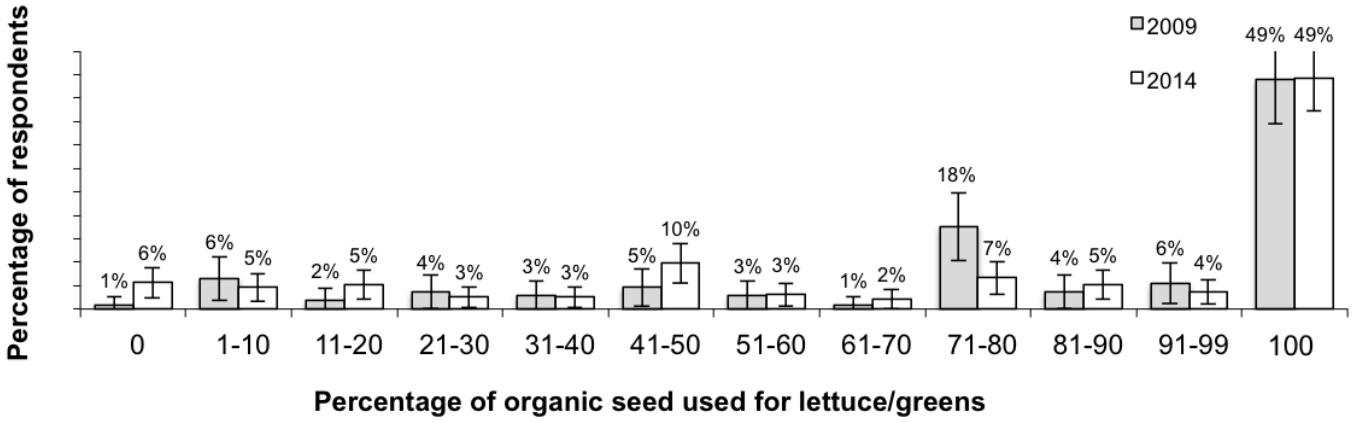


Figure 9. Percent organic seed used for SQUASH — the #3 vegetable category.

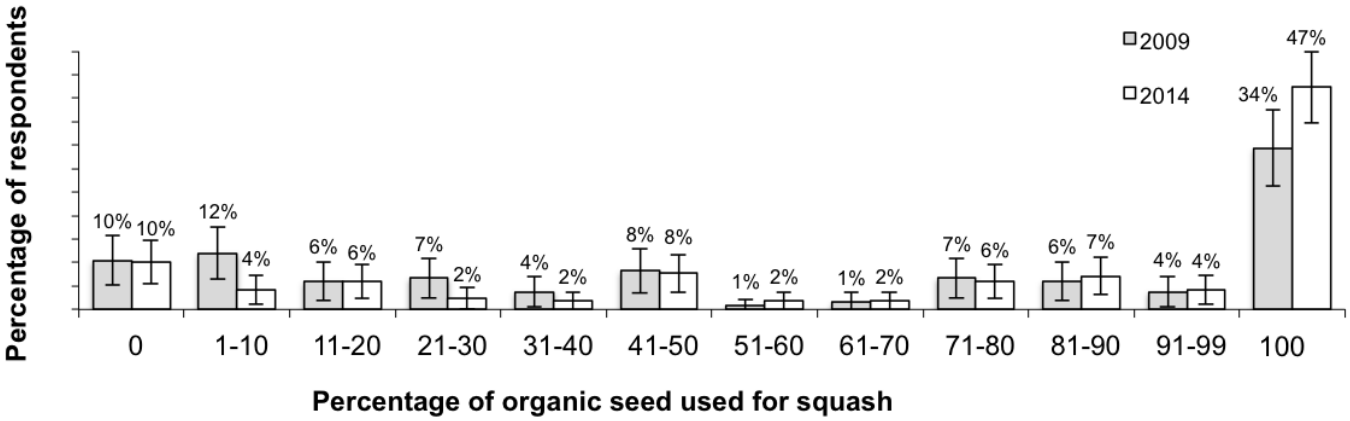


Figure 10. Did you have any organic acres in cover crops and/or green pasture last year?

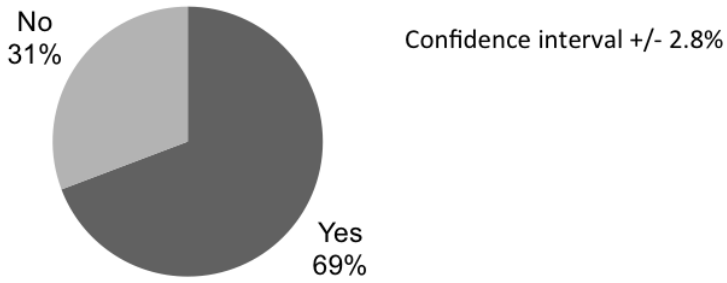


Figure 11. How many organic acres did you have in annual cover crops and/or green pasture last year?

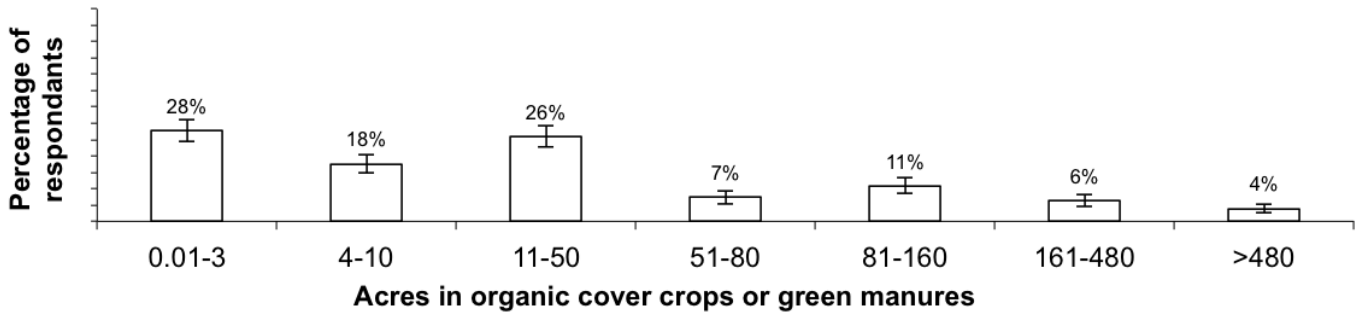


Figure 12. What approximate percentage of total acreage of annual cover crops and/or green pasture was planted with certified organic seed last year?

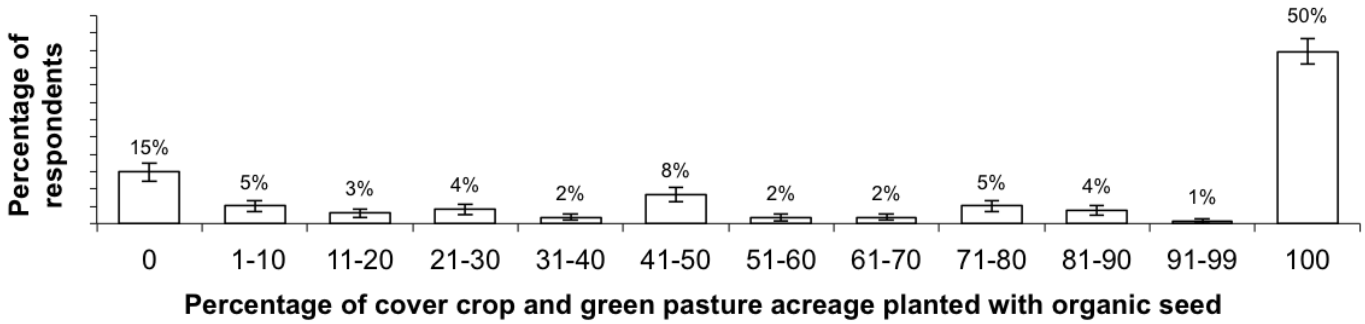


Figure 13. Average percent cover crop/green pasture acreage planted to organic seed.

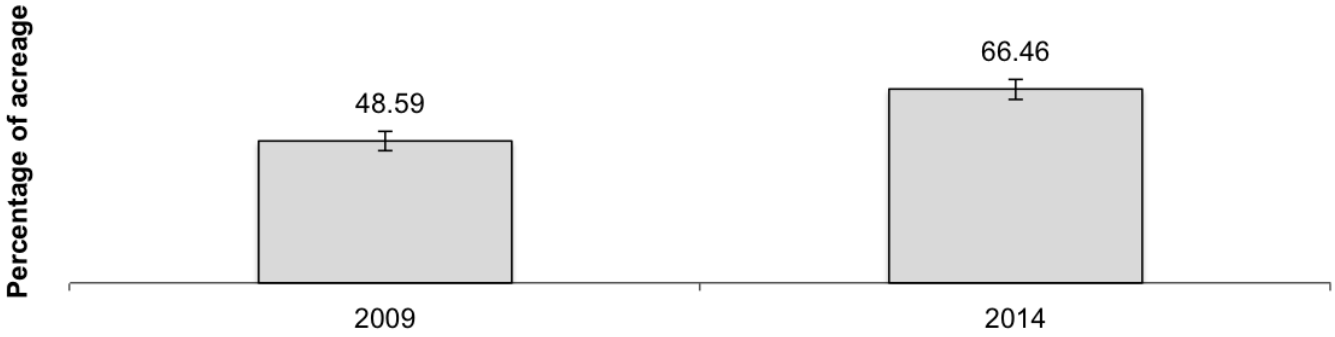


Figure 14. Average percent organic seed used for top five cover crops.

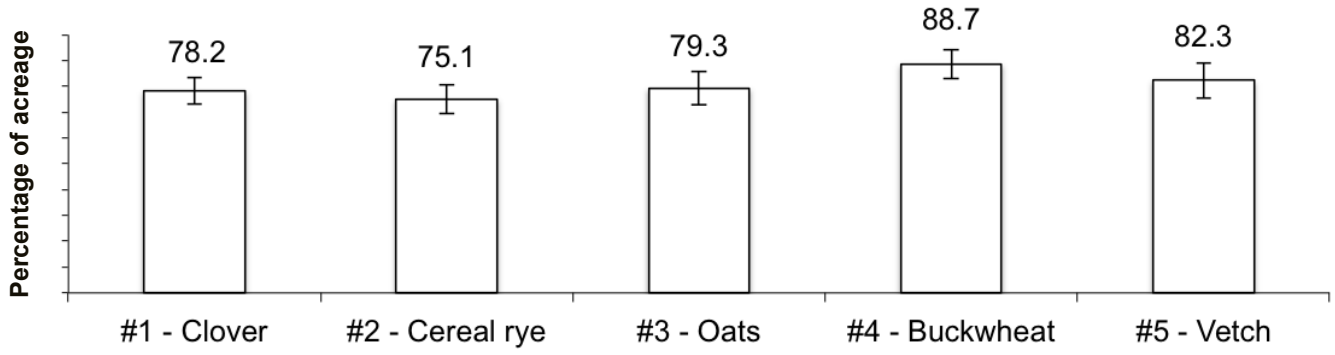


Figure 15. Did you have any organic acres in field crops last year?

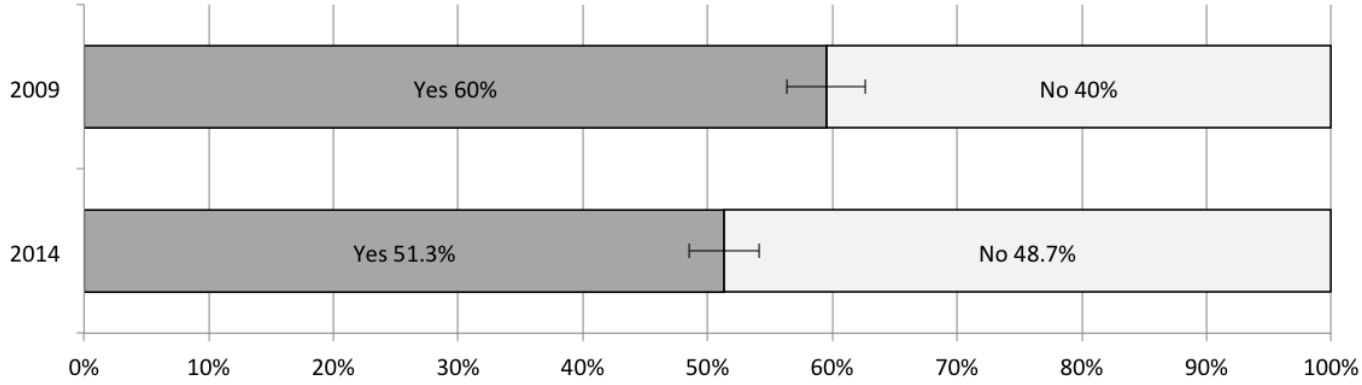


Figure 16. How many organic acres did you have in field crops last year?

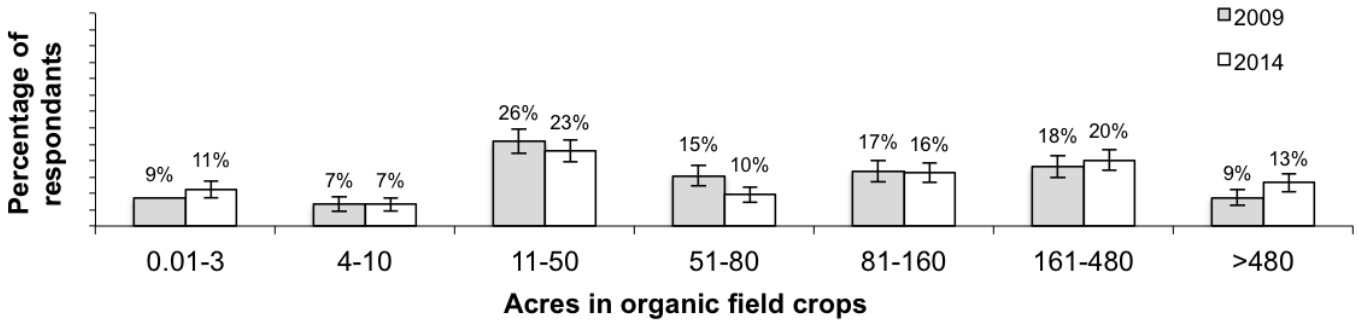


Figure 17. What approximate percentage of total acreage of field crops was planted with certified organic seed last year?

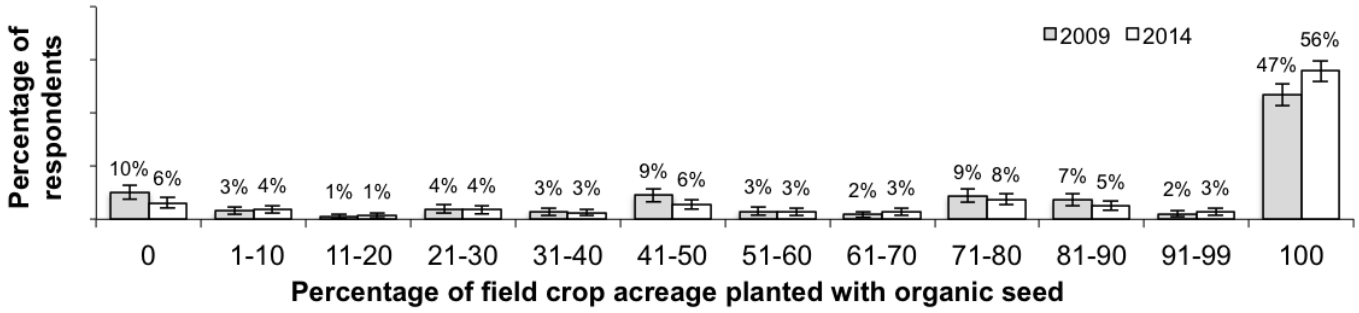


Figure 18. Average percent field crop acreage planted to organic seed.

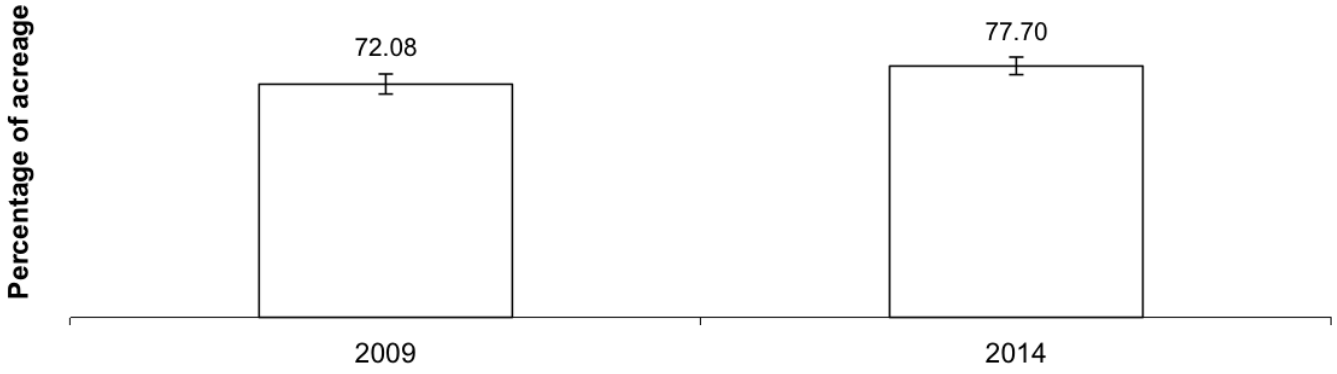


Figure 19. Percent organic seed used for CORN — the #1 field crop category.

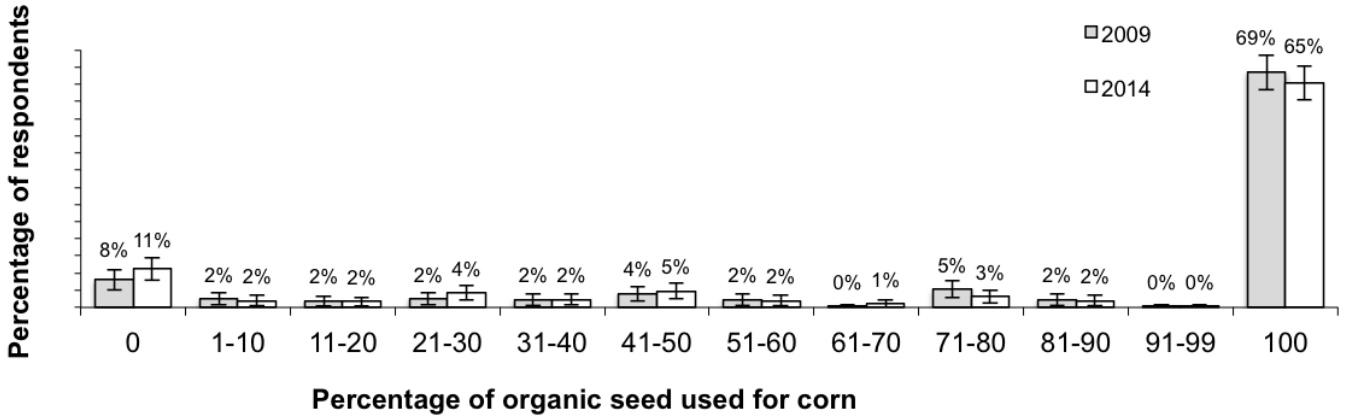


Figure 20. Percent organic seed used for SOYBEANS — the #2 field crop category.

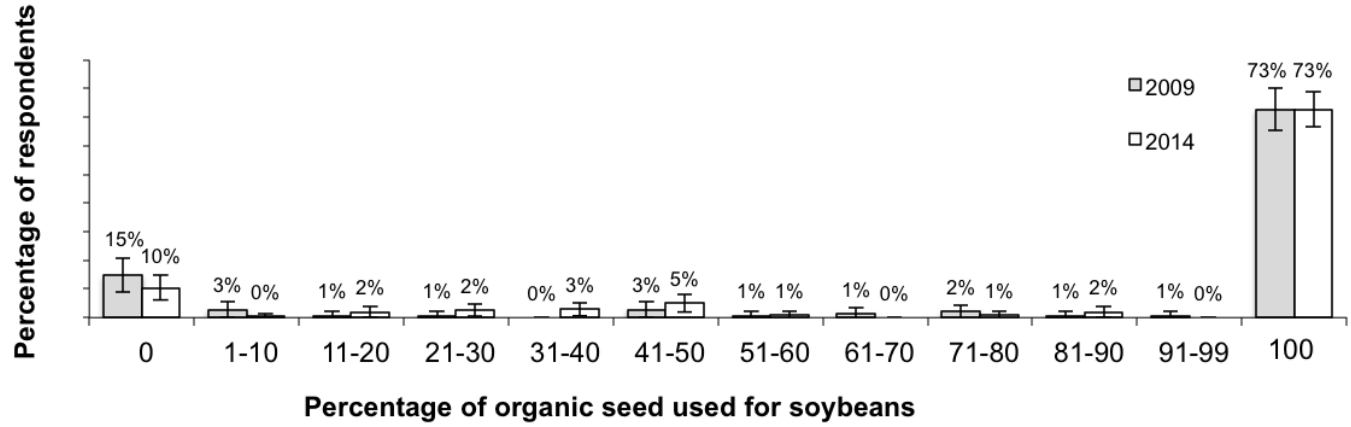


Figure 21. Percent organic seed used for WHEAT — the #3 field crop category.

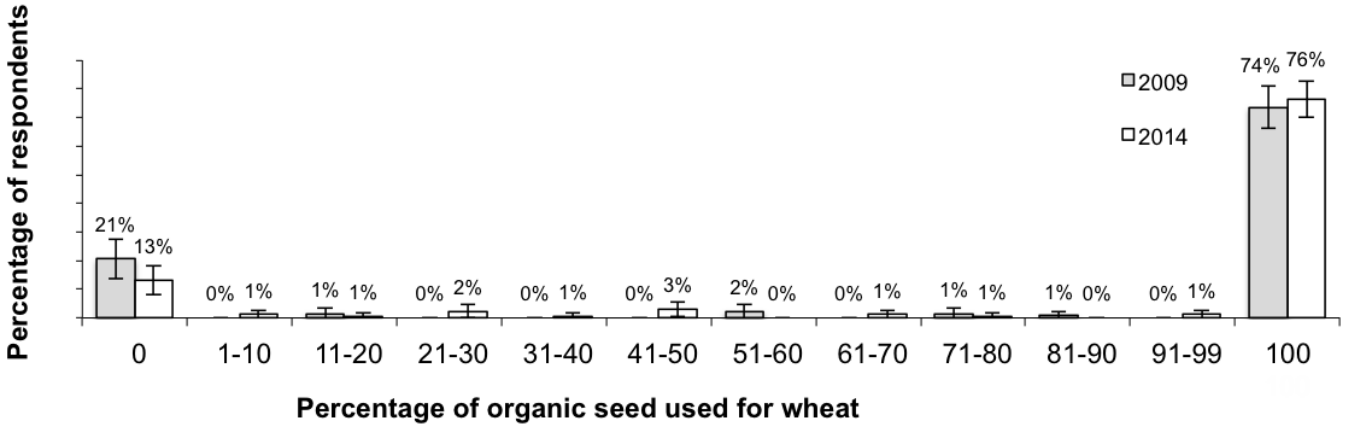


Figure 22. Did you have any organic acres in forage crops last year?

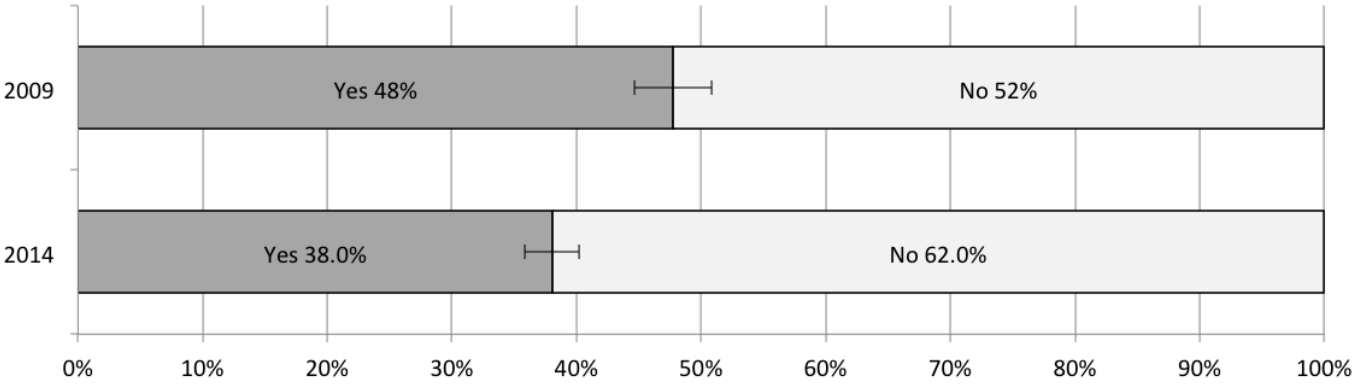


Figure 23. How many organic acres did you have in forage crops last year?

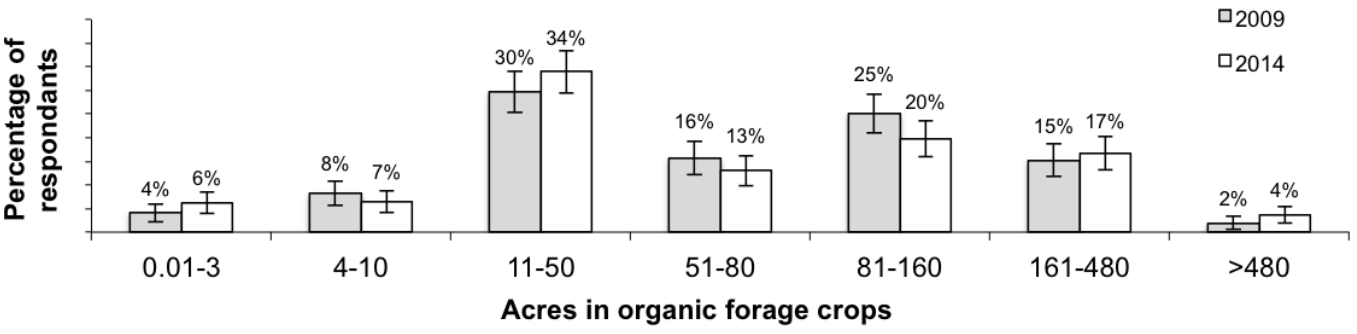


Figure 24. What approximate percentage of total acreage of forage crops was planted with certified organic seed last year?

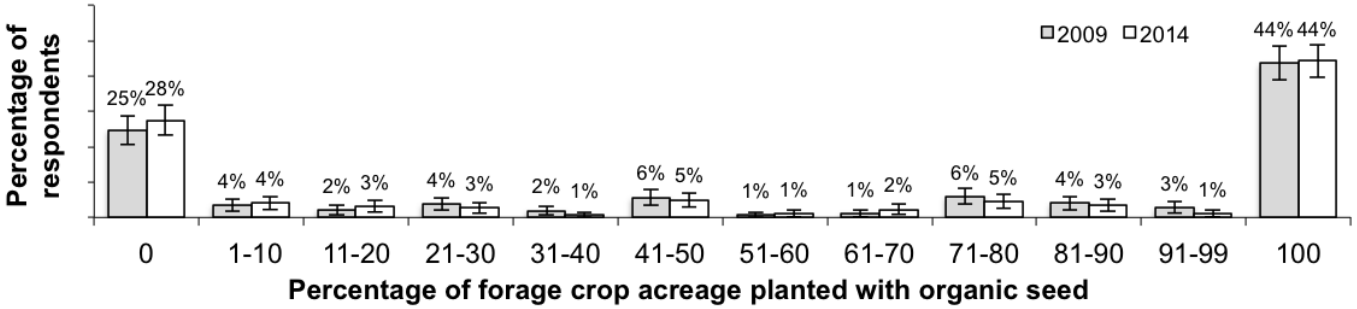


Figure 25. Average percent forage crop acreage planted to organic seed.

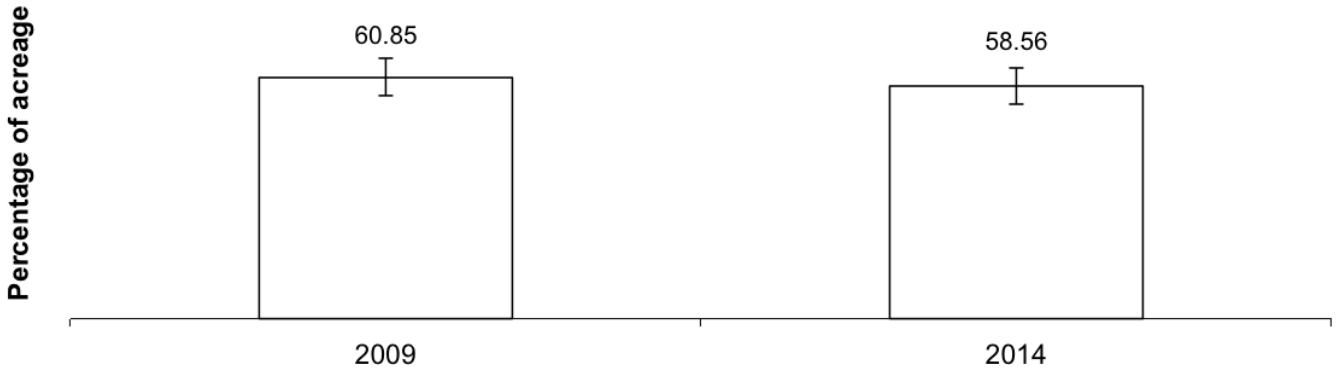


Figure 26. Percent organic seed used for ALFALFA — the #1 forage crop category.

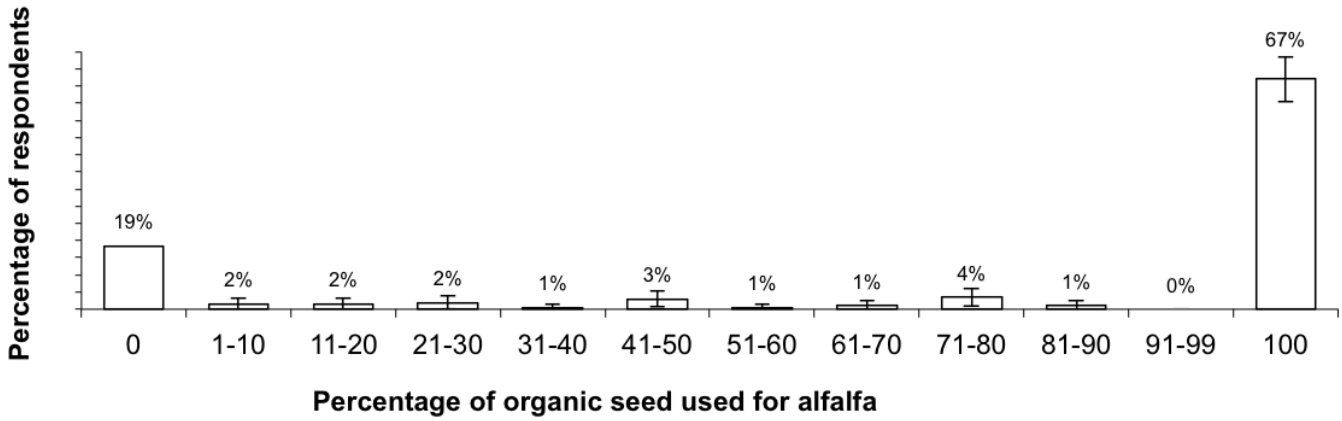


Figure 27. Percent organic seed used for CLOVER — the #2 forage crop category.

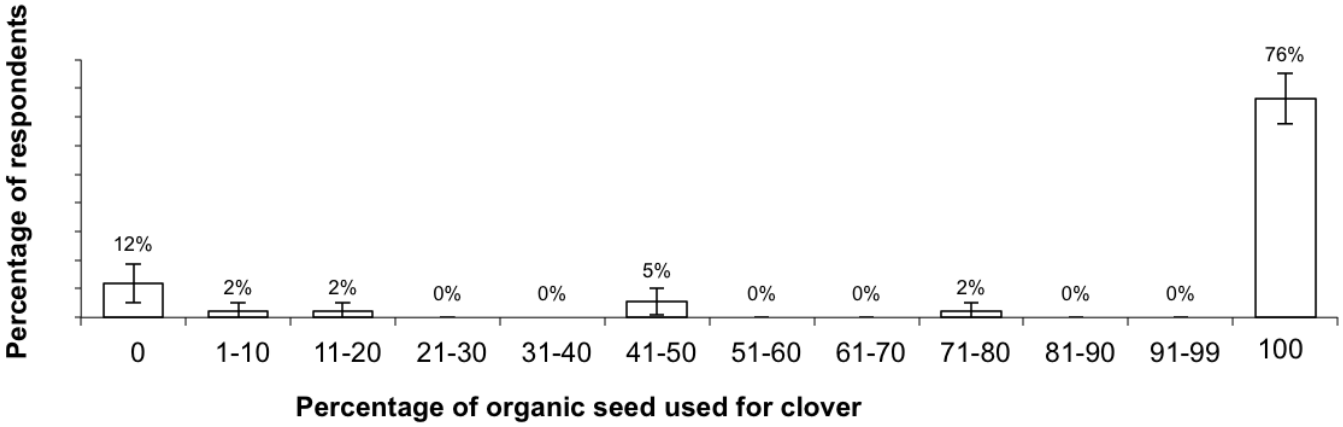


Figure 28. Percent organic seed used for GRASS — the #3 forage crop category.

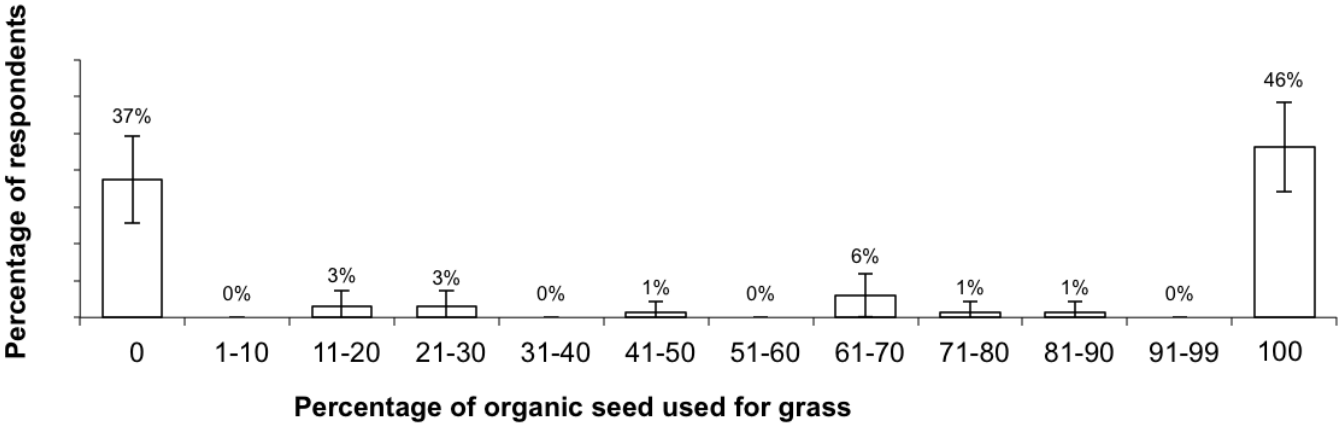


Table 1. Over the last 3 years (2011-2013) have you decreased/increased the percentage of organic seed that you use in the following crop types?

	Vegetables	Field crops	Forage crops	Cover crops/ green manure	Across all crop types
Already at 100%	18%	30%	30%	29%	27%
Increased the percentage	46%	29%	25%	30%	31%
About the same percentage	31%	38%	42%	38%	36%
Decreased the percentage	5%	3%	3%	2%	6%

Figure 29. Last year, what percentage of your seed did you get from the following sources?

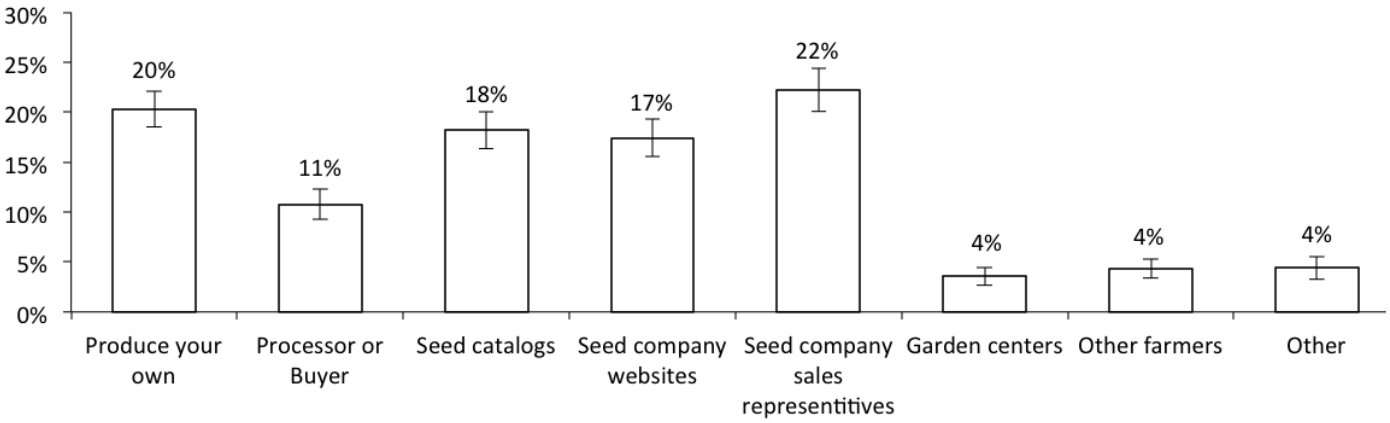


Figure 30. Over the last three years has your certifier requested that you take greater steps to source organic seed?

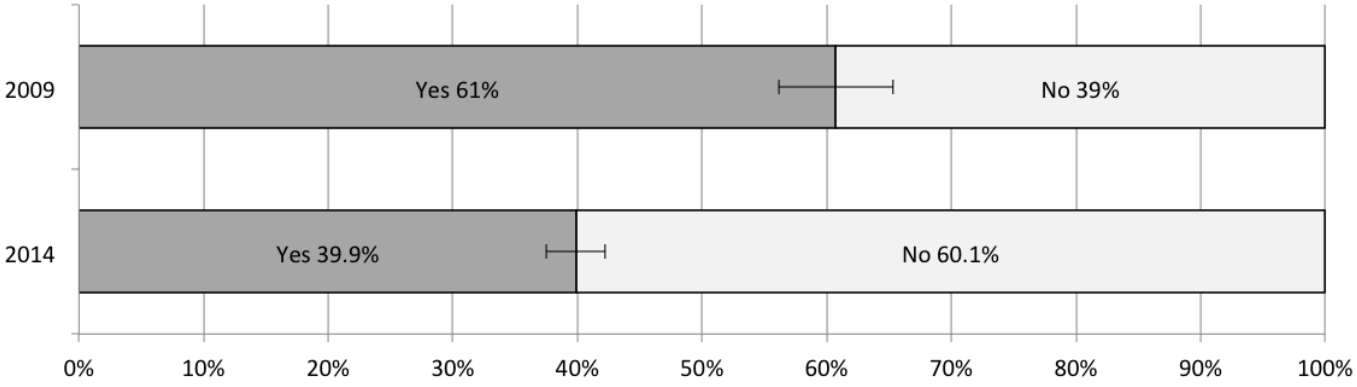


Table 2. The reasons you have not purchased organic seed over the last three years (2011-2013).

	Not a reason	Slight reason	Moderate reason	Significant reason
Lack of seed treatments such as pelleting or priming	84%	8%	4%	4%
Buyer demands varieties not available organically	73%	6%	5%	16%
Insufficient quantity of seed	44%	14%	18%	24%
Save my own seed	51%	12%	10%	28%
Distrust of organic seed quality	75%	12%	7%	6%
Price	59%	14%	13%	14%
Specific variety not available	21%	8%	14%	56%
Lack of desirable genetic traits	49%	12%	15%	24%
Seed sizing	84%	8%	5%	3%

Confidence interval: <%3.5

Table 3. Organic seed quality issues over the last three years (2011-2013).

	Not a problem	Slight problem	Moderate problem	More than moderate problem	Severe problem
Germination/emergence	51% (-1%)	23% (+6%)	16% (-0%)	7% (-3%)	3% (-0%)
Varietal integrity (i.e. not true to type)	65% (+2%)	19% (+3%)	10% (-1%)	4% (-3%)	2% (-2%)
Contamination with genetically engineered traits	88%	7%	3%	1%	1%
Physical appearance looks suboptimal	74% (+3%)	15% (-0%)	7% (-2%)	3% (-0%)	2% (-0%)
Excessive chaff and foreign matter	84% (+3%)	12% (-2%)	2% (-1%)	1% (-0%)	1% (+0%)
Seedbourne diseases	80% (+1%)	11% (+0%)	4% (-2%)	2% (+1%)	2% (+0%)
Uneven size for seeding equipment	80% (-2%)	13% (+2%)	4% (+1%)	2% (+1%)	1% (+0%)

Change from 2009 to 2014 in parentheses. Confidence intervals from ~0 to 3%.

Table 4. Changes in organic seed quality issues between 2009 and 2014.

	Not a problem or slight problem	Moderate to severe problem
Germination/emergence	4%	-4%
Varietal integrity (i.e. not true to type)	5%	-5%
Contamination by weed seed in seed lots	5%	-5%
Physical appearance looks suboptimal	2%	-2%
Excessive chaff and foreign matter	1%	-1%
Seedbourne diseases	1%	-1%
Uneven size for seeding equipment	0%	0%

Figure 31. Which additional steps has your certifier requested?

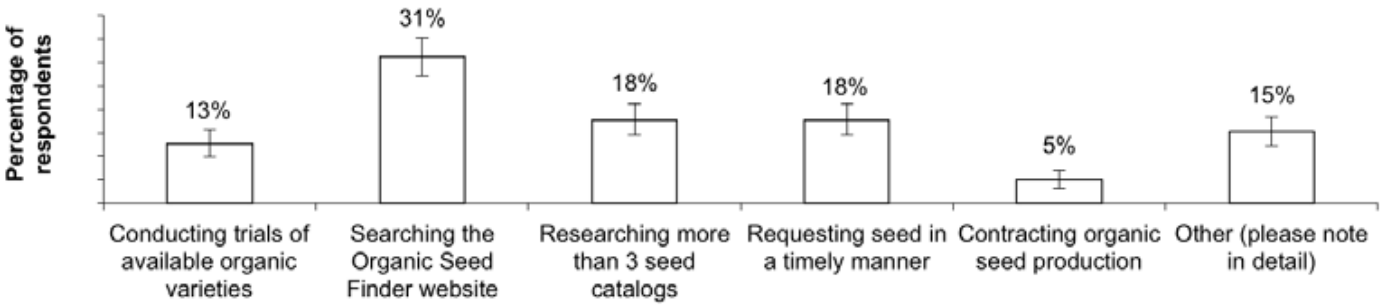


Figure 32. In general do you have more problems with seed quality issues in non-treated conventional seed or organic seed?

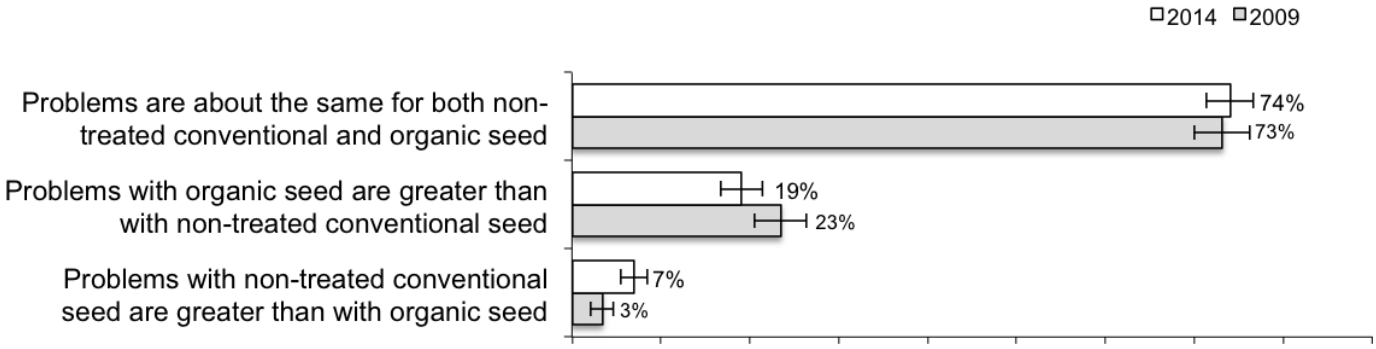


Figure 33. Agree or disagree: I use my organic seed usage as part of my marketing.

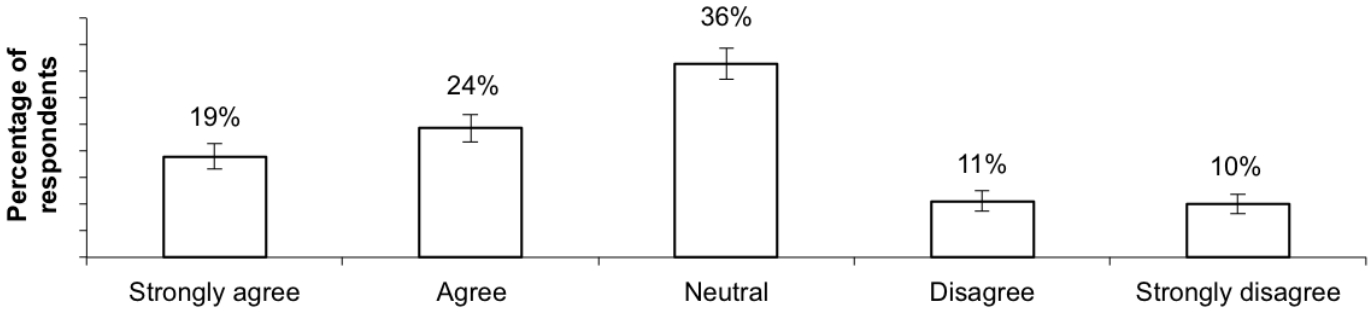


Figure 34. Agree or disagree: I want my seed supplier farming in a similar system as mine.

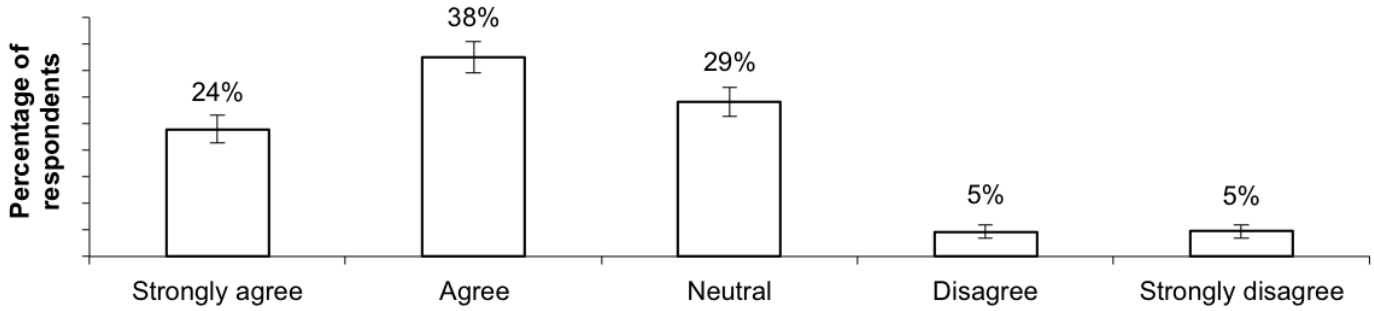


Figure 35. Agree or disagree: I want my organic seed purchases to encourage organic breeding.

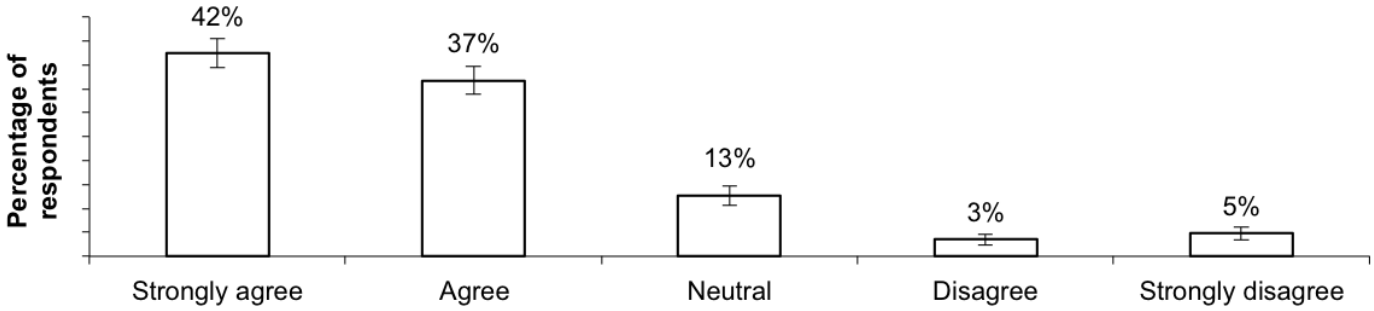


Figure 36. Agree or disagree: It is a requirement of organic certification.

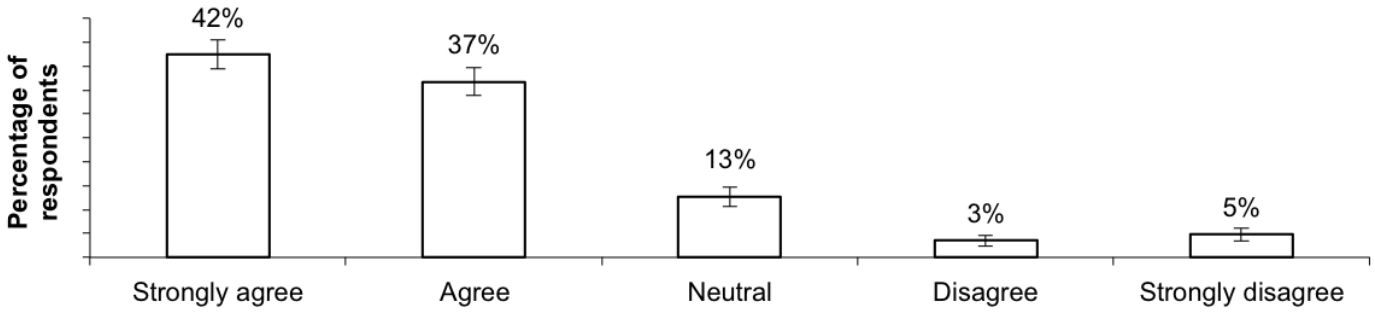


Figure 37. Agree or disagree: Seed companies should conduct testing and report rates of GE (GMO) crop contamination in organic and conventional seed.

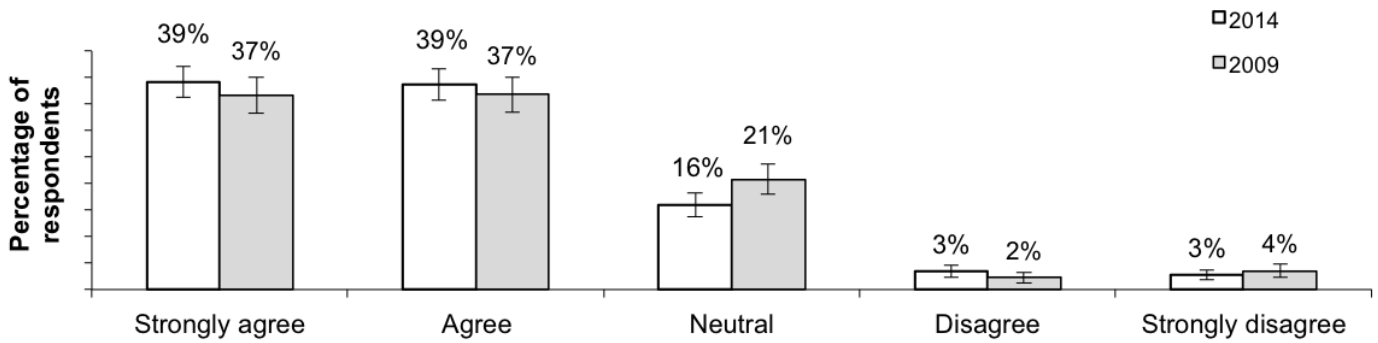


Figure 38. Agree or disagree: The federal regulations that oversee GE crop (GMOs) approvals are adequate for protecting my organic farm product(s) from potential contamination by GE crops (GMOs).

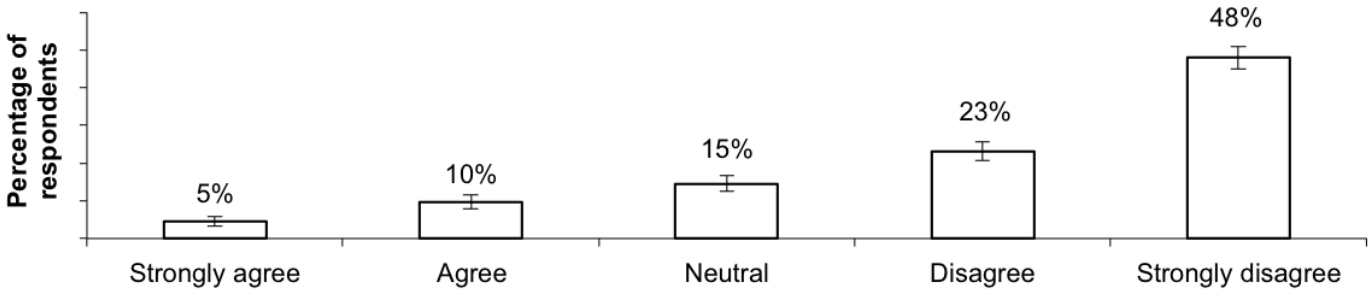


Figure 39. Agree or disagree: Organic seed is important to maintaining the integrity of organic food production.

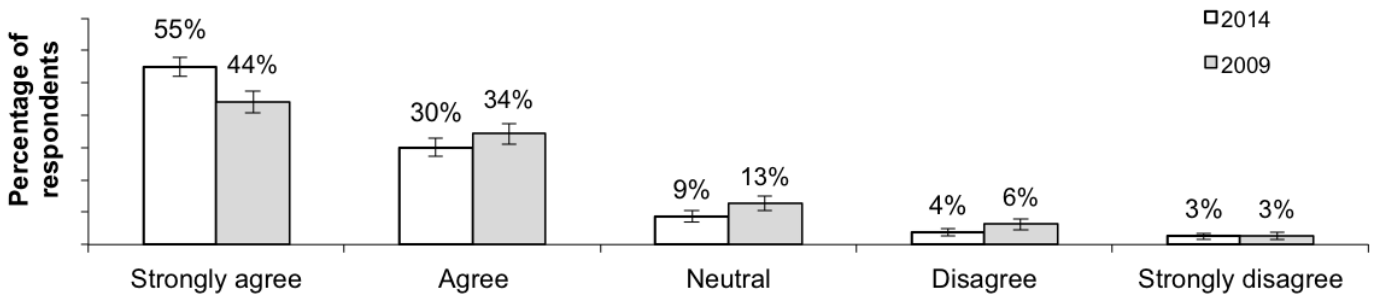


Figure 40. Agree or disagree: Varieties bred for organic production are important to the overall success of organic agriculture.

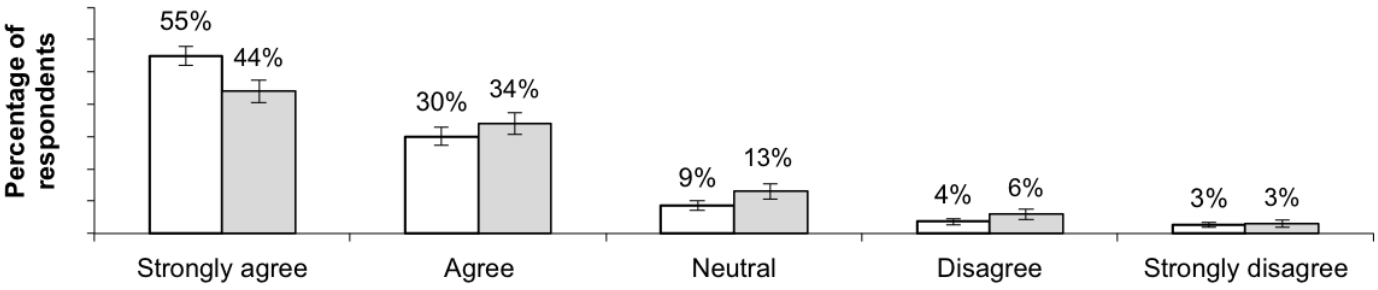


Table 5. Most important crops and traits in need of organic plant breeding.

	TOTAL votes for crop	Nutrient use efficiency	Flavor	Appear-ance	Cold hardiness/ season extension	Yield	Disease resistance/ tolerance	Germination/ seedling vigor	Competitiveness with weeds	Maturity/ earliness	Quality	Other
Corn	227 ±27	22% ±2%	7% ±1%	4% ±0%	9% ±1%	**58%** ±2%	25% ±2%	**34%** ±2%	**30%** ±2%	15% ±1%	16% ±1%	10% ±1%
Soybeans	119 ±20	10% ±1%	4% ±1%	2% ±0%	3% ±0%	**66%** ±2%	**35%** ±2%	22% ±2%	**54%** ±2%	11% ±1%	13% ±1%	9% ±1%
Wheat	91 ±18	**31%** ±2%	9% ±1%	2% ±0%	16% ±1%	**45%** ±2%	35% ±2%	20% ±1%	**34%** ±2%	7% ±1%	26% ±2%	11% ±1%
Tomatoes	100 ±18	6% ±1%	**30%** ±2%	20% ±2%	14% ±1%	**28%** ±2%	**80%** ±2%	7% ±1%	3% ±0%	9% ±1%	18% ±1%	5% ±1%
Brassicas	84 ±17	15% ±1%	18% ±1%	**33%** ±2%	11% ±1%	**38%** ±2%	**40%** ±2%	14% ±1%	8% ±1%	15% ±1%	31% ±2%	12% ±1%
Squash	49 ±13	4% ±0%	12% ±1%	**18%** ±1%	16% ±1%	**39%** ±2%	**69%** ±2%	8% ±1%	2% ±0%	10% ±1%	**18%** ±1%	10% ±1%

Figure 41. Do you think that there are crops in need of organic plant breeding?

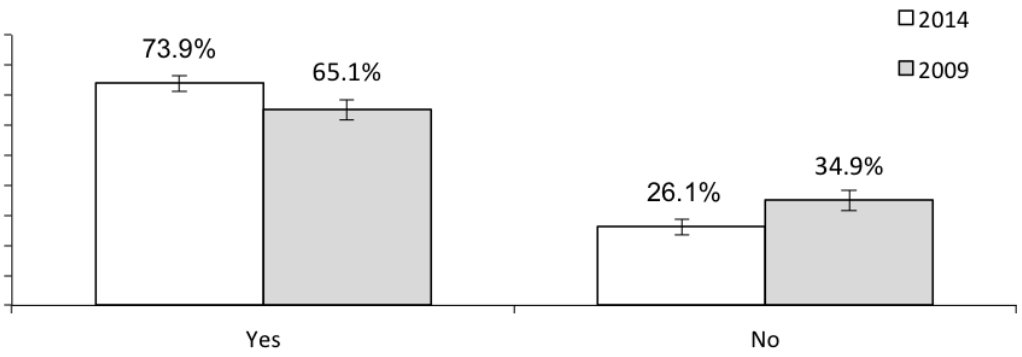


Figure 42. Which of the following categories best fits your situation pertaining to producing organic seed?

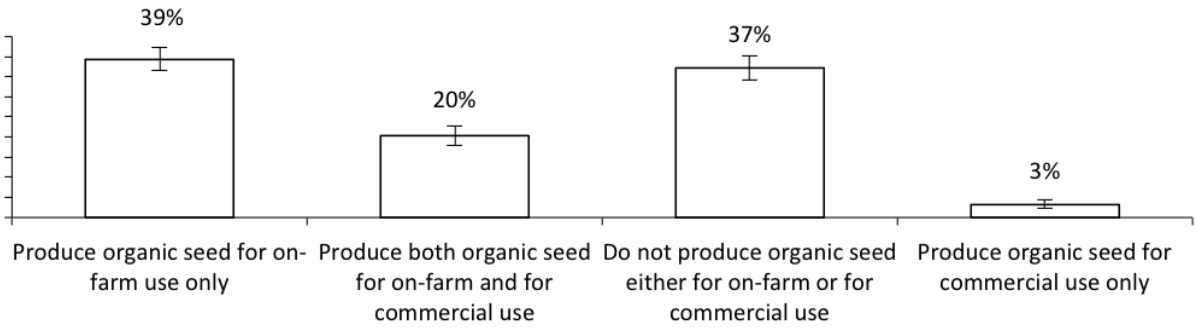


Figure 43. Have you ever produced organic seed commercially?

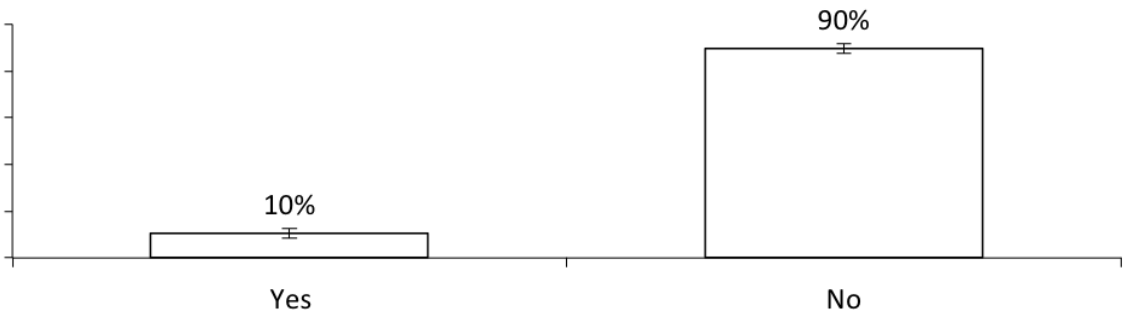


Figure 44. Are you interested in producing organic seed for commercial use at some point in the future?

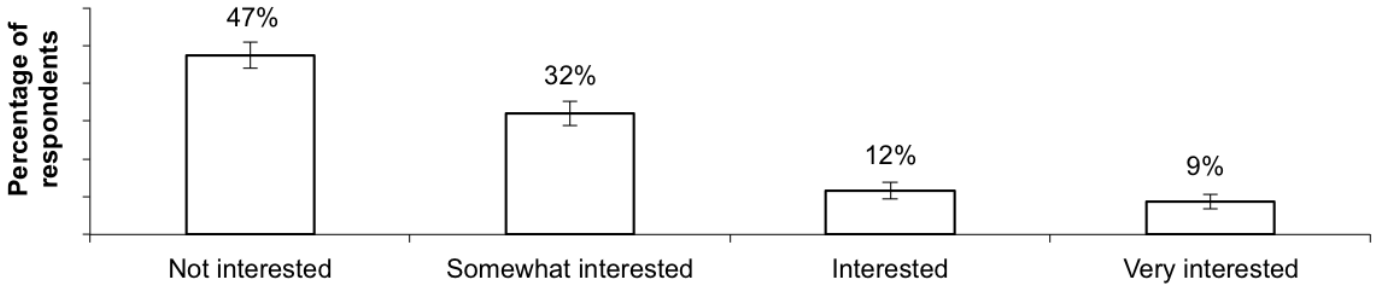


Figure 45. What factors have kept you from producing organic seed for commercial use?

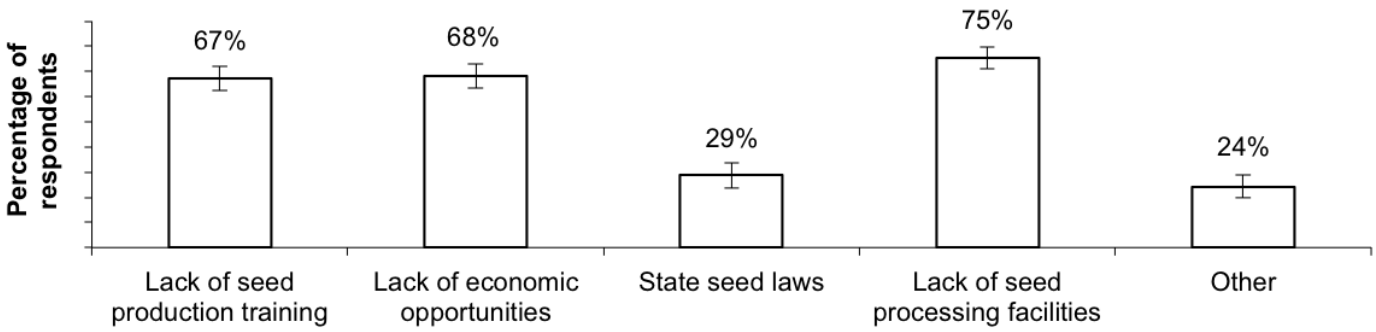


Figure 46. How interested are you in taking a training on producing organic seed for commercial use?

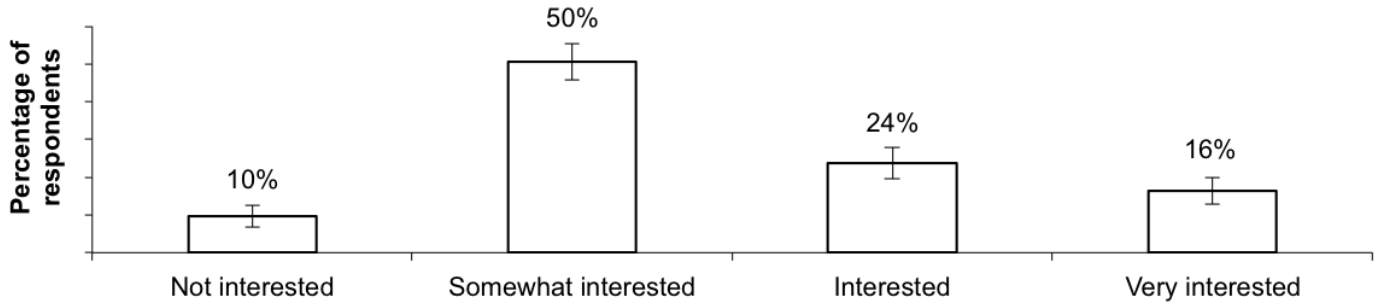


Figure 47. Are you interested in conducting plant breeding (crop improvement) on your farm?

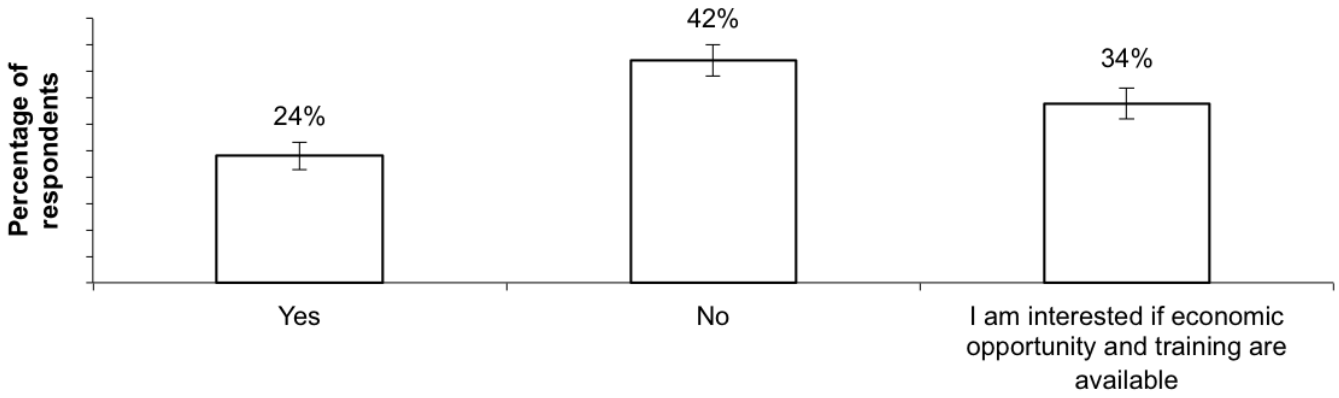


Figure 48. Number of respondents who produce specific crop types.

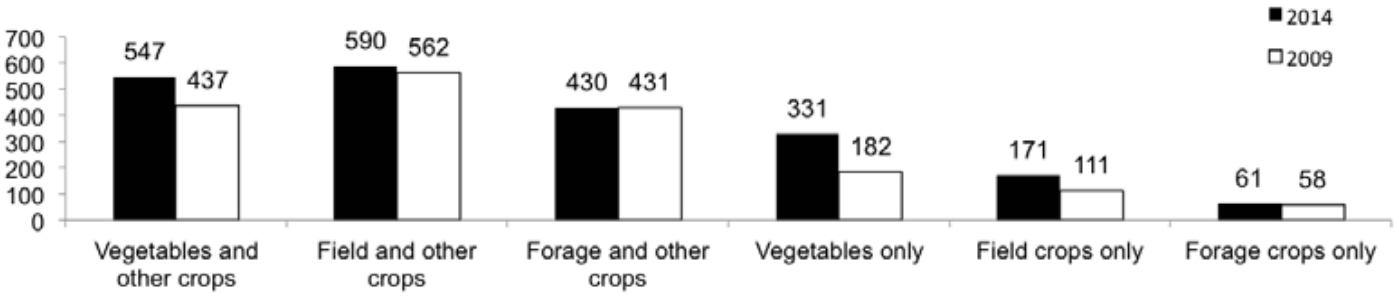


Figure 49. Respondents by farm size.

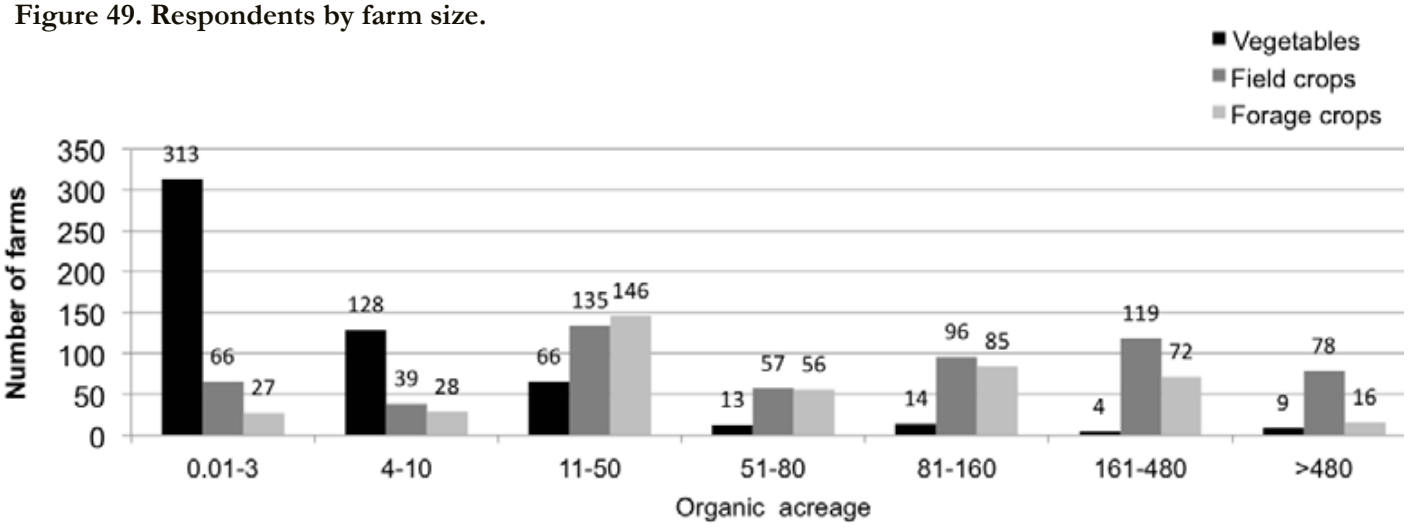


Figure 50. Overall percent acreage planted to organic seed by crop type and year.

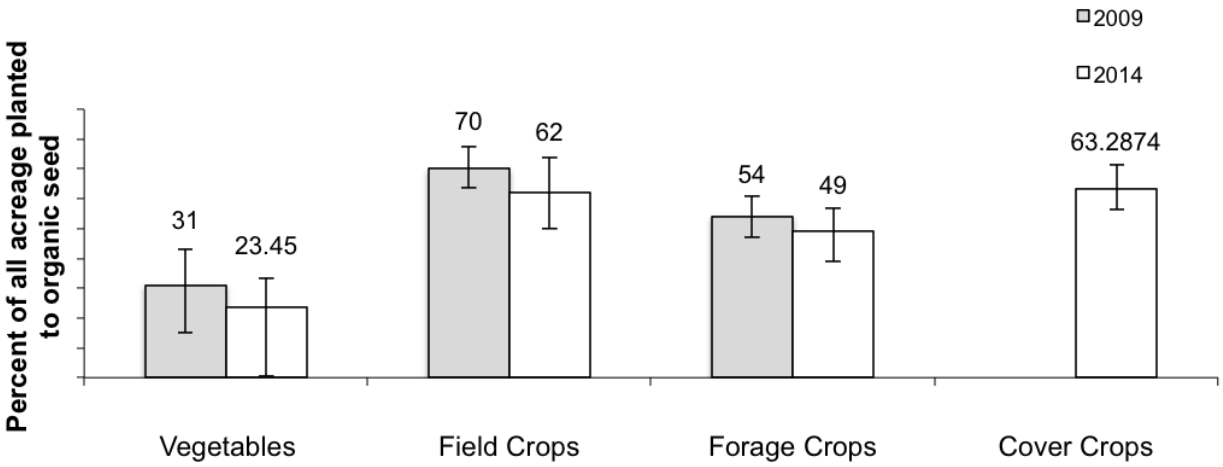


Figure 51. Organic seed use by crop type and acreage.

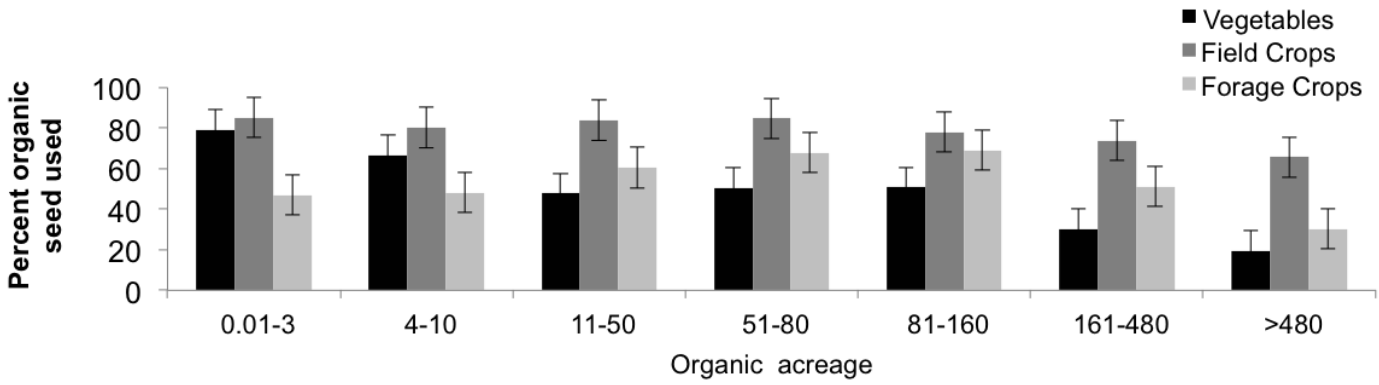


Figure 52. Reasons rated moderate to significant for not purchasing organic seed in the past.

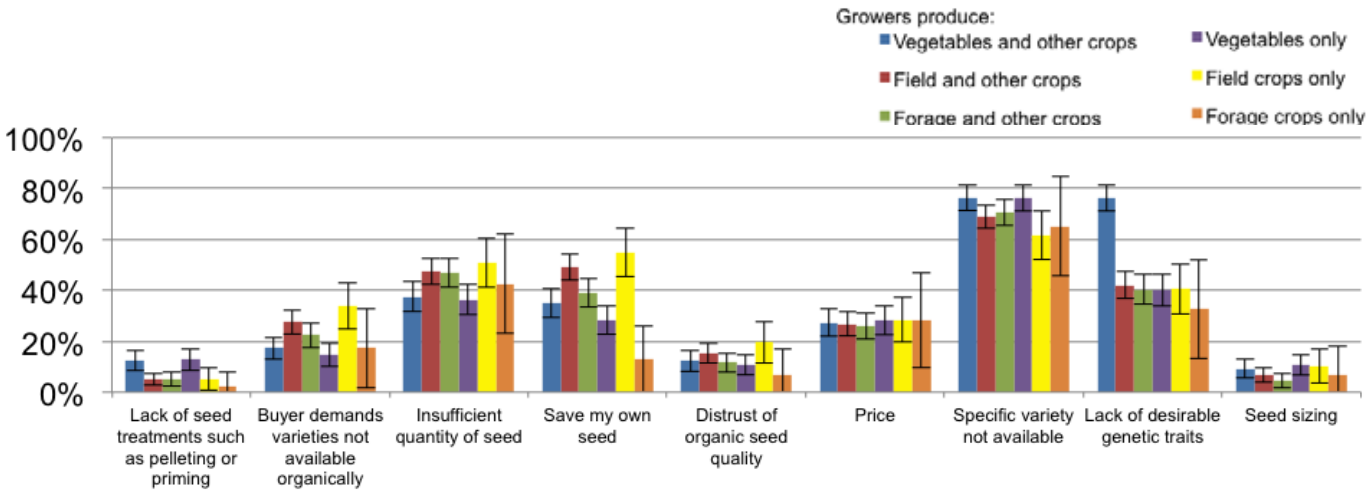


Figure 53. Seed quality problems rated moderate to severe.

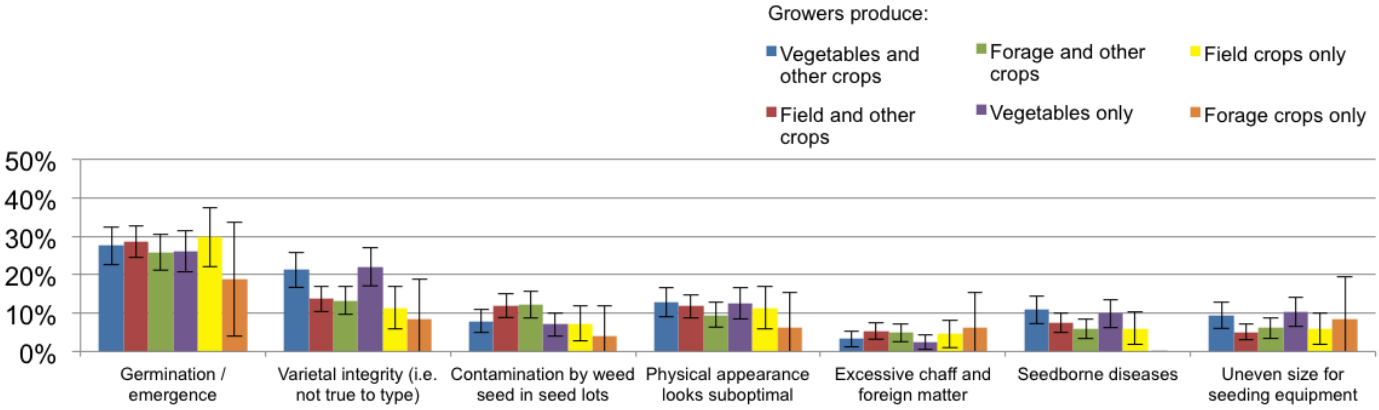


Table 6. Over the last three years (2011-2013) have you decreased/increased the percentage of organic seed that you use in the following crop types?

	Vegetables	Field crops	Forage crops	Cover crops/green manure crops
Already at 100%	18%	30%	30%	29%
Increased the percentage	46%	29%	25%	30%
About the same percentage	31%	38%	42%	28%
Decreased the percentage	5%	3%	3%	2%

Figure 54. Over the last three years (2011-2013) have you decreased/increased the percentage of organic seed that you use in the following crop types?

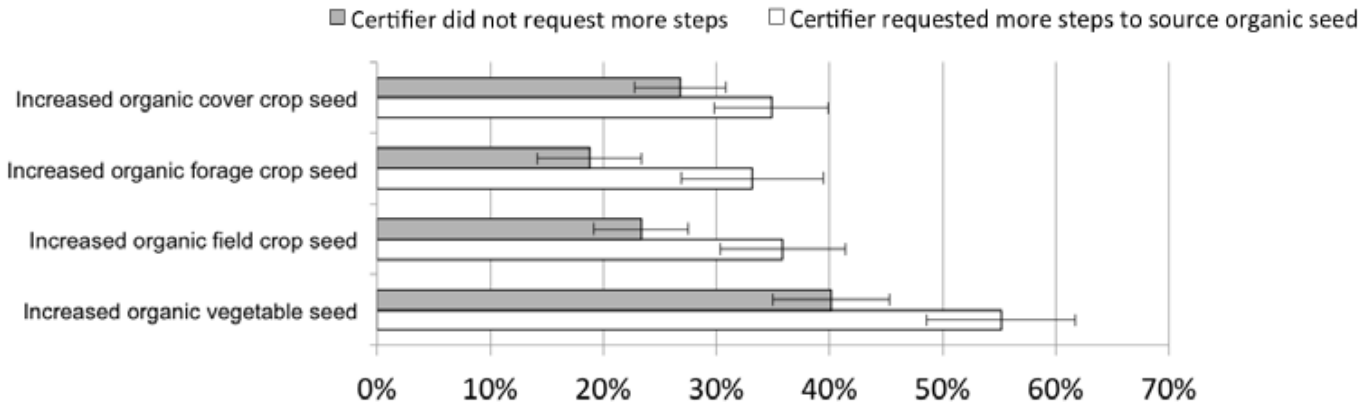


Figure 55. Reasons rated moderate to significant by vegetable producers of various sizes for not purchasing organic seed over the last three years (2011-2013).

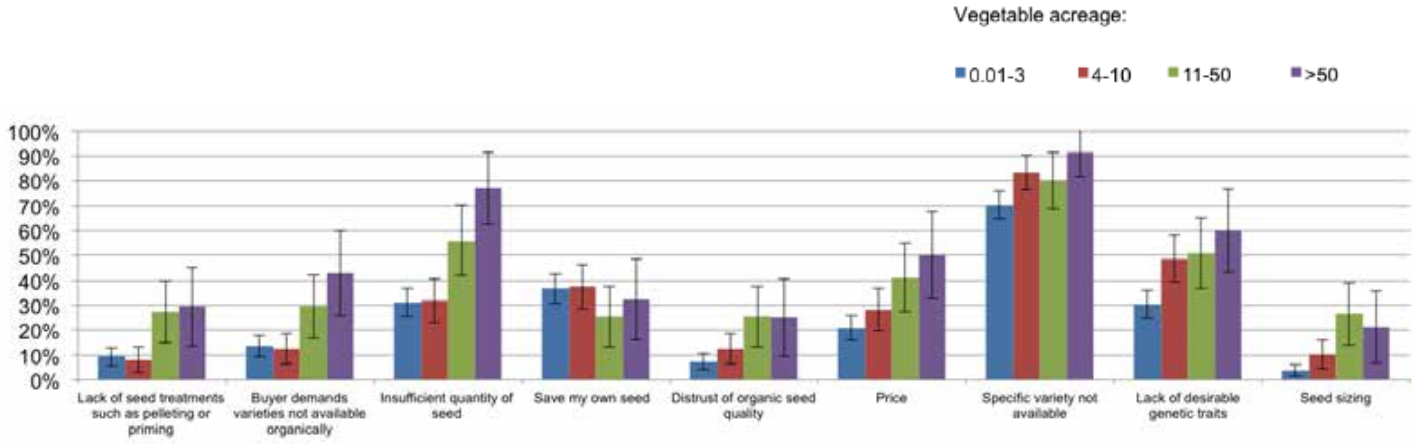


Figure 56. Reasons rated moderate to significant by field crop producers of various sizes for not purchasing organic seed over the last three years (2011-2013).

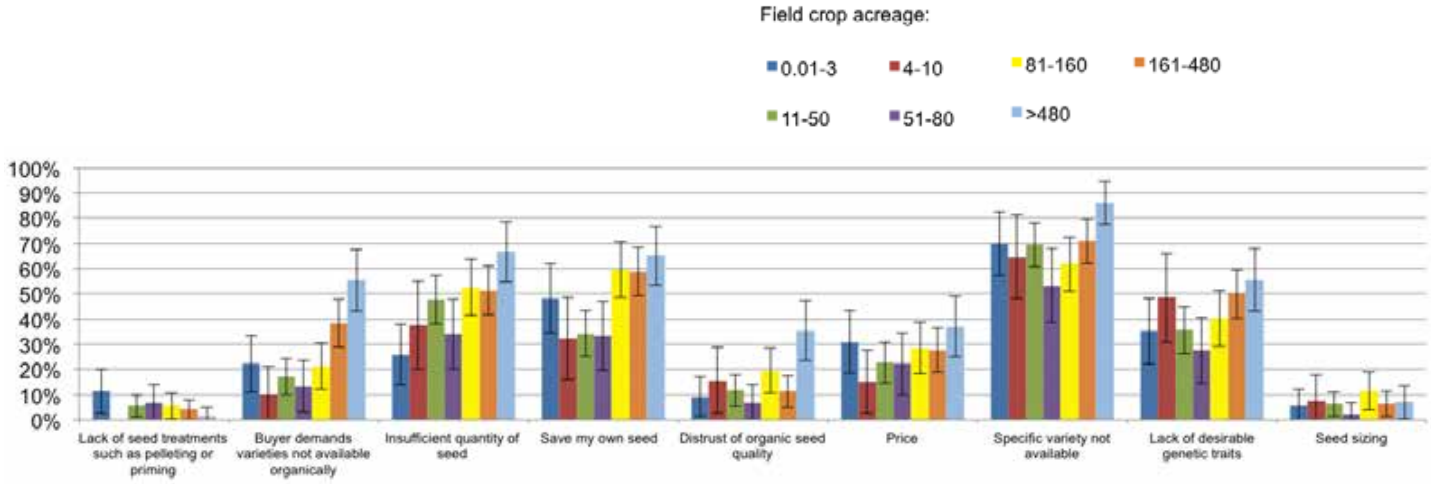


Figure 57. Reasons rated moderate to significant by forage crop producers of various sizes for not purchasing organic seed in the past.