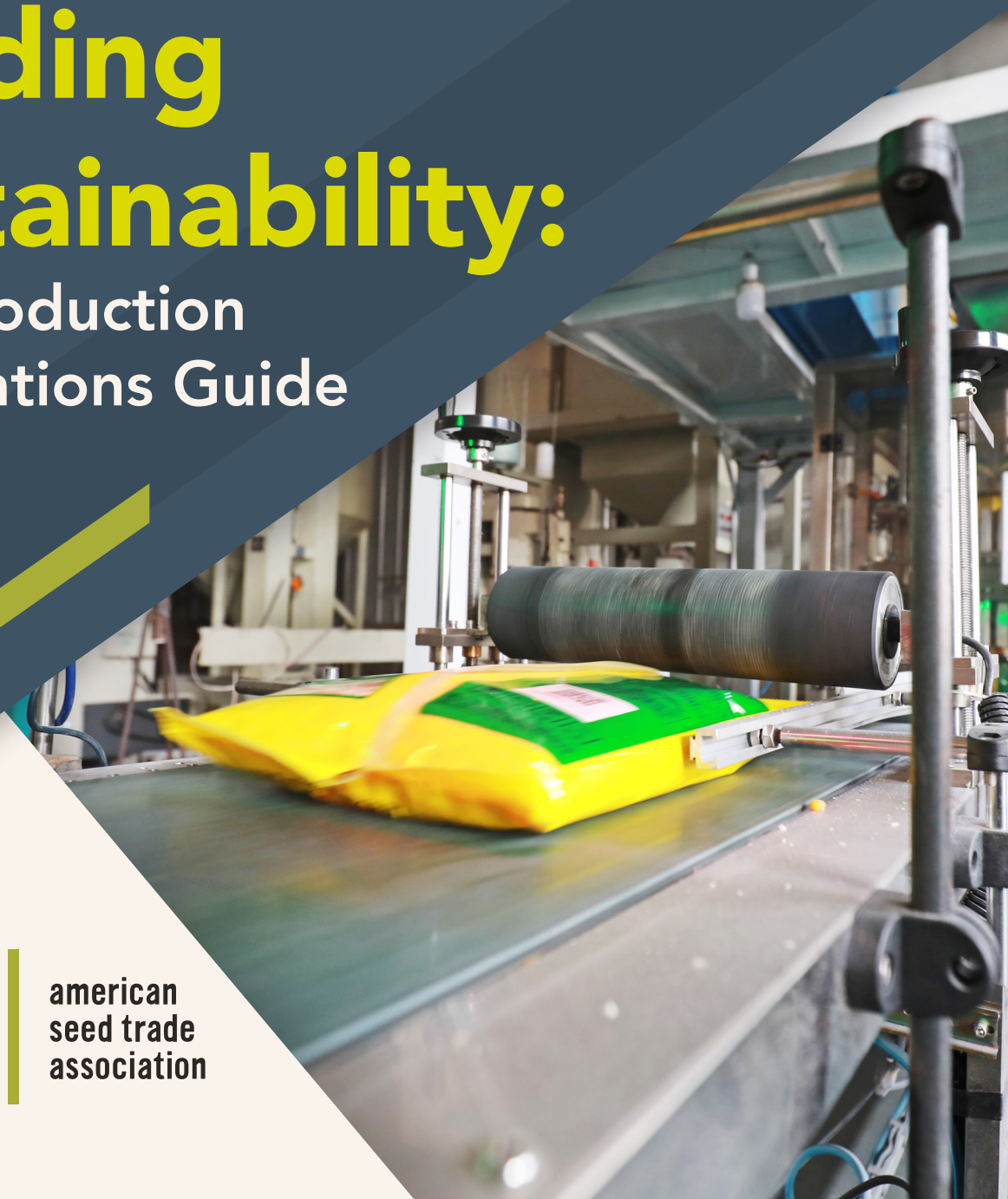
Seeding Sustainability:

Seed Production & Operations Guide



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Seeding Sustainability: Seed Production & Operations Guide ("The Guide") is intended to serve as an educational tool to assist companies that produce seed intended for food, feed, fiber, flowers, or fuel in developing their own sustainability resources. This checklist is a best practices guide for both organic and non-organic seed. The United Nations Sustainable Development Goals (SDG's) icons are included next to each industry practice.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Production Release Process

A successful production release starts with an accurate sales forecast. The production release may vary from company to company, however a proven release process will provide a steady (sustainable) supply of high quality seed year round.

Site Selection, Planting Preparation

A. **Production Location:** Consistent yield and quality will result from carefully identifying the best geographic location for seed production of the species and/or variety. Ongoing data analysis and data-driven decisions will lead to more accurate information and can allow for enough diversification to split risk. Artificial intelligence is now being used to predict climate change and could help in future crop placement.

B. **Grower Selection:** Maintain long term seed grower relationships with knowledge of the seed production process and necessary equipment. Seed companies offer fair and competitive (sustainable) prices to our growers.

C. **Proper Rotation:** Necessary to help prevent plant pathogens, volunteers, weed control and some soil borne insects. Proper rotation is continuing to evolve as we learn more about new pathogens and their life cycles.

D. **Soil Sampling:** An important step to understand the soil profile and nutrient content of the site selected prior to developing a fertility program for the upcoming crop.

E. **Cover Crops:** Help to improve soil tilth, aeration, water retention, erosion control, nutrient retention, organic material, weed suppression, nitrogen fixation, and some reduction of certain insects and nematode species. Careful consideration should be taken when choosing a cover crop to prevent volunteers during the next crop cycle. It is important to note that good timing on termination of the cover crop is necessary.

F. **No-Till, Minimum (Conservation) Till:** Promotes water conservation, less soil erosion, and can save labor and fuel.

G. **Isolation:** For insect and wind pollinated crops. Pinning maps have been put in place for proper isolation management. Important to maintain good genetic and organic seed integrity.

H. **Best Production Practices:** Transfer of "best production practices" from one production region to another.

Planting

A. **Planting Equipment:** Precision planters (air planters) reduce seed usage, conserve labor, water, and fertilizer. With organic seed production, it is helpful to have separate planters; however, the cleaning of non-organic planters to organic standards is acceptable.

B. **GPS Planting:** Improves mechanical cultivating for improved weed control and opens the door for robotic weeding by mechanical means or laser.

C. **Seed Treatments:** Provide precision and efficient placement of fungicides, insecticides, nematicides, and biologicals at low levels directly on the seed. This protection ensures the seedling has a better opportunity to develop into a strong plant, and dramtically reduces the need for field crop protection applications. Neonicotinoid seed treatments, for example, have been shown to increase yields in eight major U.S. crops. *For more information see Growing Matters Fact sheet*. Seed treatment formulations include polymers and additives that help to provide exceptional retention of the treatment on the seed during handling and planting, thereby improving coverage, and reducing dust-off. Safe handling, storage, transport, planting, and disposal of treated seed is the responsibility of everyone along the supply chain. *See ASTA Guide to Seed Treatment Stewardship for more information*. With organic production there are limited materials that can be used and must be OMRI (Organic Materials Review Institute) approved.

D. **Transplants:** Reduces the length of the crop cycle, uses less water, fertilizer, and chemicals, and allows for more efficient weed control. More efficient weed control.

E. **Grafting:** New technology with robotics has improved grafting with annuals. Primarily used on Solanaceae and Cucurbit crops to prevent soil-borne disease infections in certain locations.

Crop Management

A. Irrigation:

- **Drip Irrigation:** More efficient water usage, better placement of fertilizer, fungicides, insecticides, fumigants, and biologicals.
- **Pivot Irrigation and Modifications:** Also provides better placement of water, saves on labor, and provides an efficient way to apply nutrients.
- **Soil Moisture Monitoring Systems:** Probes that provide real-time moisture readings transmited from sensors with Bluetooth technology. More efficient water use.

B. Improved Fertility, Insect, and Disease Management: Placement and timing improvements with the help of site specific precision fertility, insecticide, and fungicide applications through satellite imaging to monitor crop health. Drone applications are now being used on some crops especially in hard to reach field locations.

C. Sanitation: In-field sanitation guidelines for field workers and inspectors help prevent the spread of seed borne plant pathogens. Easy to use in-field testing kits for several pathogens are now available to help in rapid diagnosis. Drones are being used to improve field scouting.

D. Breeding Traits: Many companies are beginning to look at seed producibility as an important index along with horticultural traits. Seed yield increases have been reported with the introduction of the following traits: drought tolerance, disease resistance, herbicide tolerance, and short corn. Another advantage of new breeding would be corn that requires less drying therefore using less artificial drying.

E. Roguing: An important tool for any seed production program to maintain a uniform genetic line or hybrid.

F. Greenhouse and Indoor Production: Technological improvements in recent years have allowed for more efficient irrigation (many with water recycling systems), soil-less technologies, improved sanitation to reduce pathogen pressure, and strict hygiene systems. For example, Good Seed and Plant Practices (GSPP) for tomato seed production.

Harvest

A. Seed Dry Down: In-field drying down of the seed crop can dramaticly reduce artificial drying and save energy. Some crops require the use of desiccants to speed up the field drying process.

B. Equipment: Larger combines can allow for greater productivity by covering more acreage in less time, thus resulting in better seed quality from good harvest timing. New technologies are available to determine seed maturation. For example, chlorophyll testing on carrots. Growing degree days have long been used as a harvest indicator. More accurate in-field hand scanners for moisture testing can be utilized with phone applications to collect field data.

In organic seed production it can be helpful to have separate harvesters; however, cleaning of non-organic harvesters, or any other harvesting equipment to organic standards is acceptable. A clean-out checklist between non-organic and organic seed is required.

C. Worker Safety: Critical during each segment of the seed production process. Personal Protective Equipment (PPE) is worn to minimize exposure to a variety of hazards.

D. Fair Labor Pratices, Living Wages, and Child Labor Laws: All are important social and economic factors that contribute to a sustainable seed production process. Companies should add their own position statement on labor practices within the context of current laws.

E. Sanitation: Harvesters, bins, and any containers handling seed being sanitized to prevent the spread of seed borne diseases.

F. Pre Ship Sampling: Sampling for quality testing from the field allows for reduced transport of poor quality seed to cleaning facilities.

Post Harvest (Operations)

A. Equipment improvements:

- **Air Screen:** Technology has improved over the past 10 years, allowing for better air controls for improved cleaning and quality. Many recent advancements have been made with automation and less operator intervention.
- **Density Separators:** Air column seperators and density separation.
- **Color sorters** with improved optics, multi wavelengths, and X Ray technology to remove impurities, cracked and chipped seed, and weed seed, which improves recovery and germination.
- **Specialized Equipment:** Seed sizers, magnetic sorters, spirals, indents, and belt seperators.
- **Advanced Separators:** Separating lots according to seed coat texture for inbreds, diseased seed as well as improving germination.
- **Pneumatics** and robotics simplify manual tasks like pallet stacking of bags, seed movement, and pallet stacking of bags.
- **Seed Priming** to improve lot uniformity and vigor as well as extended planting windows ie. desert lettuce, tomato, and watermelon.
- **Improvements in Seed Disinfection:** removing pathogens from seed that was previously discarded.
- **Seed Drying:** Sensor technology and drying technology has made tremendious improvements over the past 10 years. This saves both energy and seed.

B. Seed Testing: Seed testing is an important part in the value chain to deliver high quality seed to our customers. Continuous improvements in seed testing have evolved within the industry as new technologies are developed. This has helped to define the industry standards for: germination, physical purity, plant pathogens, residue testing, and genetics.

State and federal seed laws govern our industry and have specific guidelines on germination, physical purity, and labeling. Seed sampling by state officals is done on a routine basis to monitor labeled germination on the package. Private and public seed labs are certified and follow state, federal, and in many cases international standards when needed for international shipments.

C. Packaging:

- Bulk packaging is being utilized with many seed commodities.
- Big boxes and totes are used by several other seed handlers.
- Vegetable seed uses a large quantity of foil pouches.

Storage, Warehousing and Distribution

A. Storage and Warehousing: Improvements in temperature humidity control and monitoring during seed storage at all points along the supply chain has extended the shelf life of seed and maintained the quality. Alternative energy sources such as wind and solar are now being utilized by some companies. Insect monitoring during storage has also helped to maintain a quality product.

B. Distribution:

- A solid sales forecast helps to position the right product in the correct location and reduce the transportaion cost and distribution time.
- Availability of good onboard storage has improved seed quality at the destination. Refers for sensitive seed lots. Ie. primed seed.
- Speed of delivery is also an option when needed.
- Newer technology of tracing temperature and humidity with sensors is being utilized.
- **Lot Traceability:** The seed industry has, for many years, had a trace back, trace forward lot numbering system. Each seed company has their own unique lot numbering system which can trace the individual crop from a specific production location to each customer it was sold to. With this information, specifics on the production, operation, testing details, and sales of each lot can be obtained.
- **Seed Disposal:** Disposal of poor quality or obsolete seed is a necessary part of a satisfactory inventory management process. Donation of seed to non profit organizations, and use of seed as a fuel source for power plants that use biomass or solid waste as alternitive fuels are two examples of sustainable disposal.
- With treated seed, companies carefully calculate how much will be needed each year. However, if the treated seed is damaged or does not meet quality specifications it may require disposal. *For more information, see ASTA's Guide to Seed Treatment Stewardship*. Companies may add individual disposal methods used to maintain proper inventory control.

SDG Guide

SUSTAINABLE DEVELOPMENT GOALS

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