

# **The Winnow Wizard**

## **Operating Instructions and Techniques**

### **(1 HP)**



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**For educational videos, seed cleaning strategies, and additional information, visit [luterra.com/winnow-wizard](http://luterra.com/winnow-wizard)**

## **The Winnow Wizard Story**

Mark Luterra built the first prototype Winnow Wizard in December 2014 while working for Wild Garden Seed in Philomath, Oregon. He had just been tasked with hand-winnowing some 300 lbs of Persian cress seed, and his wrists were sore and his body was tense from trying to pour seeds just so behind a box fan. Conventional wisdom was that winnowing in front of a fan or blower was too turbulent to be useful, but Mark had experience with laminar flow hoods in microbiology which used a metal grating to create a uniform, even flow of air and decided to see if the same technique could produce a better winnower.

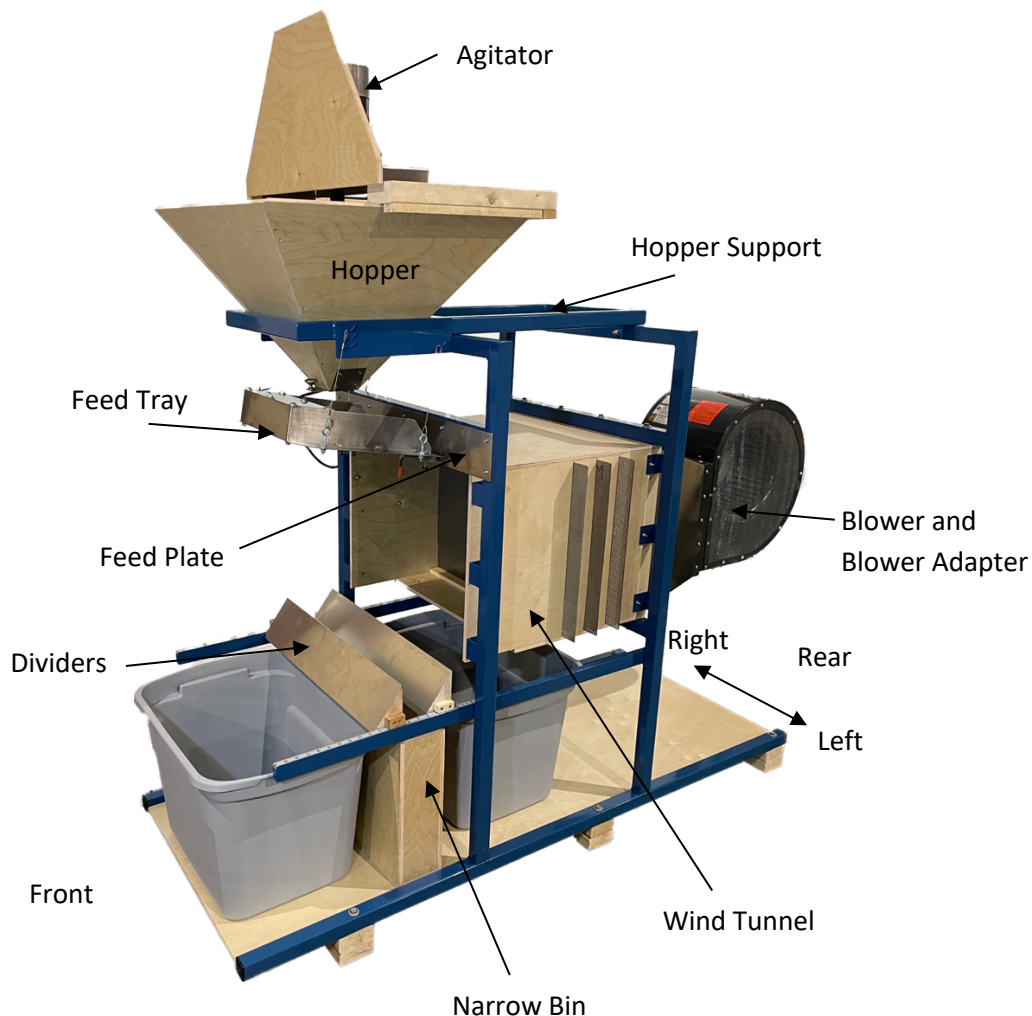
Wild Garden Seed liked it so much that they commissioned a second, much-improved machine in early 2016, and farmers visiting for nearby Organic Seed Alliance conference that year were sufficiently impressed that they started putting in orders. Many called it a “game-changer” for small-scale organic seed production.

Mark built 105 Winnow Wizards in his tiny, open-air Philomath shop, using mostly wood and hand tools, from 2016-2022, gradually making improvements and producing a few more each year until it became a full-time job. Faced with a need to expand and not wanting to be a full-time woodworker forever, Mark sought a partnership with a manufacturer with a similar open-source, small-is-better vision and ultimately selected Oppen Works in Viroqua, Wisconsin.

The new, mostly-metal design represents an evolution in durability, adaptability, and precision, and (we hope) stands poised to join Clippers and Allis-Chalmers tractors as a machine that will be passed down and treasured by generations of farmers and seed stewards.

## Unpacking and Assembly

Image below shows final assembly diagram.



1. Remove one of the sides of the crating, only remove the top row of screws on the ends to remove the panels. Once one side is removed and all the bottom screws on each side are removed the winnow wizard can be removed out from one side while lifting the crate carefully.
2. Remove all strapping/crating and set loose components aside. Ensure that there is no damage from shipment and that the magnetically-attached screen in the wind tunnel is in place. (If necessary, re-attach it with the handle at the top.)
3. If desired, remove shipping skids by removing the lag screws and sliding the 2x4s out from under the machine. (Skids add 3" to overall height but enable the machine to be moved with forks.)
4. Place the hopper in the support frame so that the gate opens away from the blower.

5. Suspend the feed tray from the hopper support frame, placing the cable loops over the square-bend hooks. Use the middle hooks on the back side for an initial angle setting. Ensure that the tray sits level and that there is approximately equal tension in the four cables. Adjust cable tension with the nuts on the eye bolts if necessary.
6. Route the feed tray wire through the frame opening above the feed plate and plug the adapter into the lower right outlet. Use twist ties to shorten excess cord if necessary.
7. Set the agitator on the hopper as shown, with the motor shield facing away from the blower. Plug the cord into the upper right outlet.
8. Install the “triangle twist” agitator attachment. Open gate fully. Align the groove on the shaft with the set screw. Insert until the attachment rides  $\sim\frac{1}{4}$ ” above the hopper gate. Tighten the set screw using the supplied hex key. Rotate the attachment by hand and ensure that it is centered in the bottom of the hopper. Adjust the motor mount tilt if necessary for centering.
9. Unpack and install sliding screens for desired airflow setting (see p. xx). Screen labels should be at the upper corner facing away from blower.
10. Place a seed divider on the ruled rails with the vertical edge nearest the blower. The second divider and narrow bin are only needed in special cases (see p. 7).
11. Plug the machine into a grounded 115V, 20A outlet. (The plug will not fit in a standard 15A outlet.)
12. Find some seed and do a test run.

### Precautions

- Plug the Winnow Wizard into a properly grounded 20 amp electrical outlet.
- Do not store, operate, or transport in wet conditions. In addition to possible motor damage, air diffusion screens will rust if exposed to moisture for prolonged periods.
- Do not operate unattended; turn motors off when not in use.
- Do not operate without blower intake screens in place.
- Keep hair, loose clothing, and necklaces away from blower intakes and hopper agitator.

### Maintenance

- Keep blower intake screens clean.
- Monthly, or more often in dusty conditions, remove and clean the permanent screen nearest the blower.
- Annually, or more often in dusty locations, remove intake screens and feed tray motor cover. Clean blower motor, shaker motor, and blower blades with compressed air. Clean agitator motor whenever significant dust buildup is detected. Dust buildup reduces efficiency and is a possible overheating/fire hazard.
- **Clean vibration motor every 50-100 hours** with compressed air or dust cleaner product. Inspect mounting bolts and tighten nuts if necessary. Remove top (2 screws) to access on sides of feed tray.

### Transport

- With all detachable components removed, the base unit can be carried by three people: one in front and one on each side under the blower (Approximately 240lbs). Lift by the bottom frame rails only.

- If the machine needs to be moved frequently on a level surface (e.g. from storage to operating location), six casters can be added under the frame rails (3/8" diameter thru holes located front, center, rear on each rail).
- For highway travel, remove and secure all detachable components and stuff a towel/sweater into the blower from the inside to prevent it from spinning in the wind.
- If the Wizard will be subjected to especially rough handling (e.g. mobile installation on a trailer), Oppen Works is not responsible for damage to equipment during transport.

## **Operating Instructions**

### *Siting*

The Winnow Wizard needs to be level and located away from ambient winds. Dust and chaff will land 10-20 feet in front of the machine, so this area should be open and ideally covered with a tarp.

### *Seed preparation*

Seed needs to be field-cleaned before running through the Winnow Wizard. Too much fine chaff will prevent seed from flowing out of the hopper, and large debris will clog the hopper outlet and feed slot. In general, it is sufficient to do one field winnow followed by one screening using a screen no larger than twice the diameter of the seed. If equipped with a hopper agitator, this precleaning requirement can be relaxed, but most seed lots will still require a coarse screening to remove large debris that may clog the agitator, hopper gate, and feed slot.

### *Sizing*

Aerodynamic density is proportional to seed diameter, so smaller seeds will blow farther than larger seeds. If viable seeds have a wide range of sizes, it is helpful to size them first with screens before a fine winnowing step.

### *Slot width*

The feed slot width needs to be wide enough to pass the largest chaff in the lot, but in general should be made as small as possible. The smaller the slot width, the more uniform and vertical the trajectory of the seed falling into the airflow. The slot width needs to be matched to the feed rate from the hopper to avoid filling up the feed tray. In general, a slot width of approximately 1/16"-1/8" wider than the largest dimension of the seed is ideal for fine winnowing.

### *Feed tray adjustments*

Seeds should move down the feed tray toward the slot when vibration is turned on. The slower their horizontal motion, the less they will bounce off the vertical feed plate and the less random spread will be introduced. A steeper angle setting is best for soft or flat seeds, while round seeds like brassicas, peas, and beans benefit from a shallower angle to avoid excessive horizontal bounce. The tray can be shaken manually to feed the last seed in a lot.

- If seed moves to one side of tray (and machine is level), adjust cable-attachment eye screws to level feed tray and equalize cable tension.
- Use the two sliders and thumb screws to adjust the gap between the feed tray and feed plate.

### *Feed rate*

To a point, the slower the throughput, the more accurate separation will be. With fewer seeds dropping, there is less scatter from collisions in the feed slot and less wind interference from nearby falling seeds. For maximum accuracy, select the smallest hopper opening that maintains a steady flow across the full width of the feed tray. In our practice, we usually start with a fast-feed, wide-slot “rough winnow” to remove 90% of the chaff, run the seed over scalping/sifting/sizing screens, then do a final winnow with a slower feed, narrower slot, and shorter divider setting.

### *Wind speed*

Wind speed should be adjusted so that most of the good seed is deflected between 3” and 13”, though it is possible to winnow light seeds by setting the divider beyond the rails. With too little wind, random seed bounce predominates over air separation. With too much wind, turbulence becomes noticeable as the air stream interacts with ambient air. Some screen combinations create more even airflow than others; the table below is based on empirical testing. Feel free to experiment with different combinations, within the constraints listed below.

Blower speed: H (high), L (low)

Restrictor screens: O (open – no screen in slot), S (3/64” holes),

M (1/16” holes), R1 (50% obstructed), L (1/8” holes)

Screen slots: 1 (closest to exit), 2 (middle), 3 (closest to blower)

Setting	Slot 1	Slot 2	Slot 3	Blower	Wind speed (mph)	Power (watts)	Sample Applications
High	S	O	L	H	11	1850	Grains, beans, peas, removing rocks
Medium	S	M	L	L	8	1350	Brassicas, beets, quinoa
Low	S	M	R1	L	4	970	Amaranth, teff, lettuce
Very Low	S	M	R2	L	2	850	Smallest flower seed (e.g. Yarrow)

### Notes

- Never operate without screen S in Slot 1. Without sufficient static pressure the blower motor may overload, and airflow will be too turbulent for effective winnowing.
- Do not use high blower speed with screens M, R1, or R2 in place. With the airflow restricted, high speed will increase noise and power consumption with no winnowing improvement.
- Insert screens so that the labels appear as shown below. Due to minor imperfections in the perforation process, orientation can affect airflow evenness left-to-right and top-to-bottom. Each machine is tested and screen orientation optimized for best performance.



### Electrical specs

17.5A, 2000W, 120V, 60Hz (20A circuit and outlet required)  
 machine is at full power, 15A at 1875W when machine is off)

Aux. outlets: 400W max (when

Feed tray: <0.1A

Agitator: 2.5A

Blower @ top speed: 15A

### Hopper Agitator (optional)

#### *Setup and operation*

1. Ensure hopper is oriented with gate pull facing forward (away from the blower).
2. Install desired attachment using 5/32" hex wrench on shaft set screw.
3. Place agitator on hopper with cord above switched outlet and dust/seed shield facing forward.
4. Plug agitator into top switched outlet. Motor will start when machine is switched on.
5. Set feed tray to the middle or upper angle setting, and set the feed slot wide enough for the largest chaff/debris.
6. **Start agitator motor before pouring seed into hopper, especially with lots containing abundant sticks or awns. Starting torque is lower than torque at operating speed.**
7. Motor casing will be hot to the touch (~130°F) in normal operation. Keep motor air intake/exhaust free of dust and rogue seeds.

#### *Attachment selection*

- The "triangle twist" attachment is most useful for dirty/dusty/stick-filled seed lots. It can be used with any amount of gate opening. Use caution with soft/fragile seeds (e.g. zinnias, marigolds, cucurbits) – run a small sample first and inspect for seed damage.
- The "wiggle wire" attachment is most useful for large/fragile seeds that don't naturally flow well, e.g. zinnias, cucurbits. It creates less abrasion/rubbing than the triangle twist but is less effective with especially dirty/stick-filled seed.

#### *Triangle Twist*

- Adjust shaft up or down (using set screw) so that wire is ~1/4" above hopper gate and does not rub against hopper walls when rotating. Bend wire to center if necessary.



- Screen seed to remove large debris (>1") and long sticks (>3-5") before pouring into hopper. Large debris may stall agitator and cause damage to agitator paddle or hopper opening.
- Keep hands, long hair, and dangling clothing out of hopper when agitator is operating.
- **Do not allow agitator to slow or stall. Motor may overheat. If slowing/stalling occurs, either perform additional screening/threshing steps before winnowing, or add material to hopper in smaller amounts.**

### *Wiggle Wire*

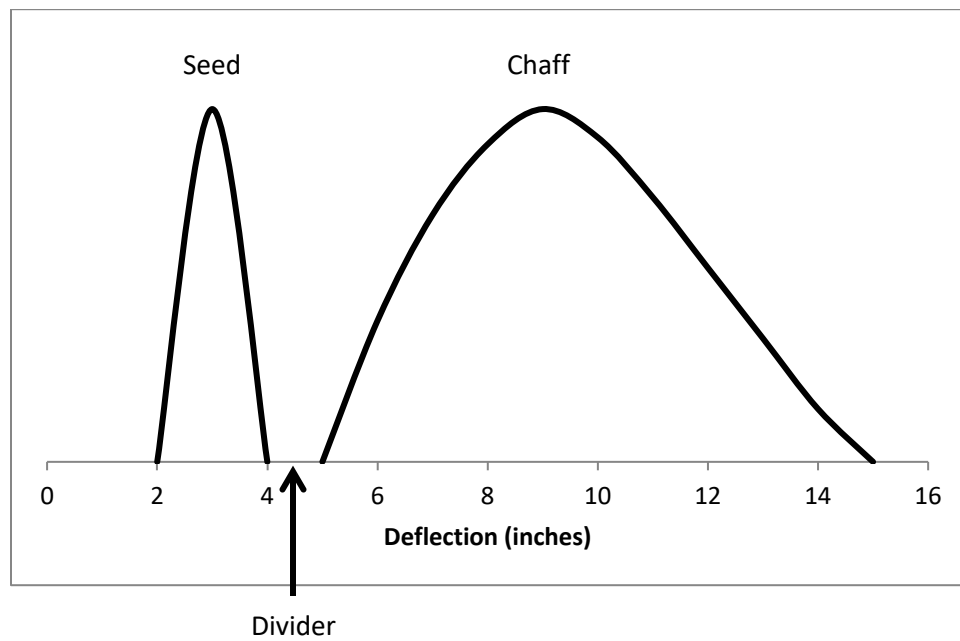
- Open hopper gate fully before installing. Wire should stick through gate slightly. Do not close gate fully during operation.
- Bend wire such that it sweeps through an arc but does not rub excessively against hopper opening when rotating.
- Performance may decrease if hopper is more than ½ full.

### **Winnowing Techniques**

(Visit [Luterra.com](http://Luterra.com) for more seed cleaning strategies: [url://](http://url://))

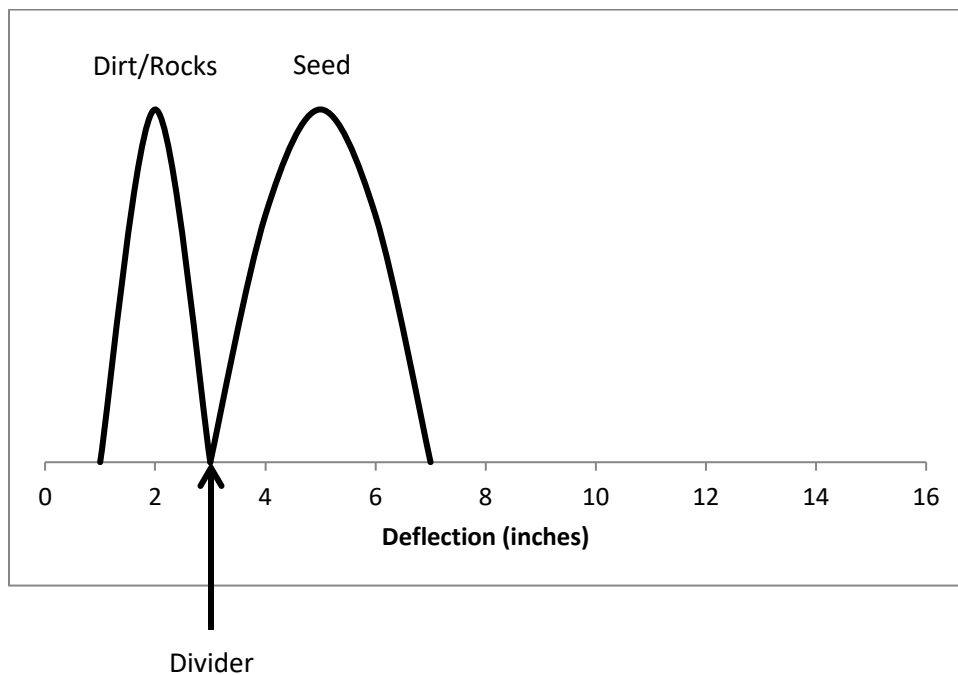
#### *Single-pass split*

For heavy round seeds – including most brassicas – it is possible to set a division point that retains 99% of the good seed while removing 99% of the chaff. Fill the hopper, watch it run, pack up the clean seed, pat yourself on the back for growing easily-cleaned seeds, and grab a beverage of your choice...



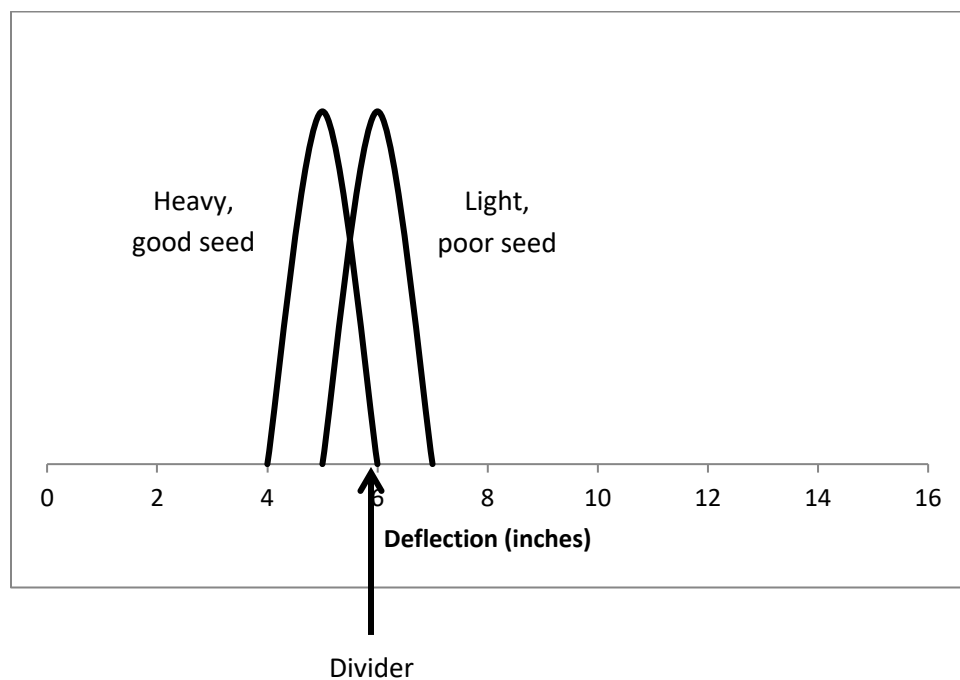
### *Overwinnowing dirt/rocks*

If your seed contains heavy debris (usually dirt clods and rocks), it is sometimes possible to blow the seed away from the dirt with maximum airflow. I have done this often to get chunks of dirt out of beet seed. Set the divider in a location such that ~99% of the seed lands beyond it, then re-winnow the dirt fraction at the same setting to recapture that 1% of seed. Heavy seeds like basil, quinoa, and brassicas are not readily separated from dirt by winnowing; in those cases the magnetic separator attachment may be helpful.



### *“Shaving” to increase germination*

In general, lighter seeds are less viable than heavier seeds, so it is usually possible to increase germination by winnowing away the lightest seed. At Wild Garden Seed we have had great success using the Winnow Wizard to raise germination from 50-70% up to 85% or higher. The trick is to winnow away the correct proportion. If a seed lot tests at 66% germination, aim to shave away 1/3 of the seed. Because there is always some random spread, it is best in this example to set the divider to remove about 20% of the seed, then re-run the heavy fraction once or twice until about 1/3 of the seed has been winnowed out. If possible, run a germ test on both the heavy and light fractions to confirm success before throwing away the light seed.

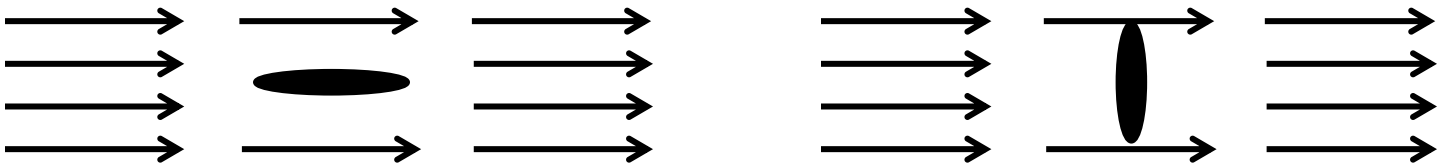


### *Winnowing flat seeds: the shrinking middle*

Winnowing is a probability game. Let us assume that we have a perfectly uniform population of round seeds, all the same size and density. For these seeds, all spread will be due to the machine itself: slight bounces off of the feed plate, slight turbulence in the airflow, and airflow interference caused by seeds

falling close together. This random spread should be less than 2" horizontal at a 6" deflection, which is to say that 99% of our theoretical identical seeds would land between 5" and 7".

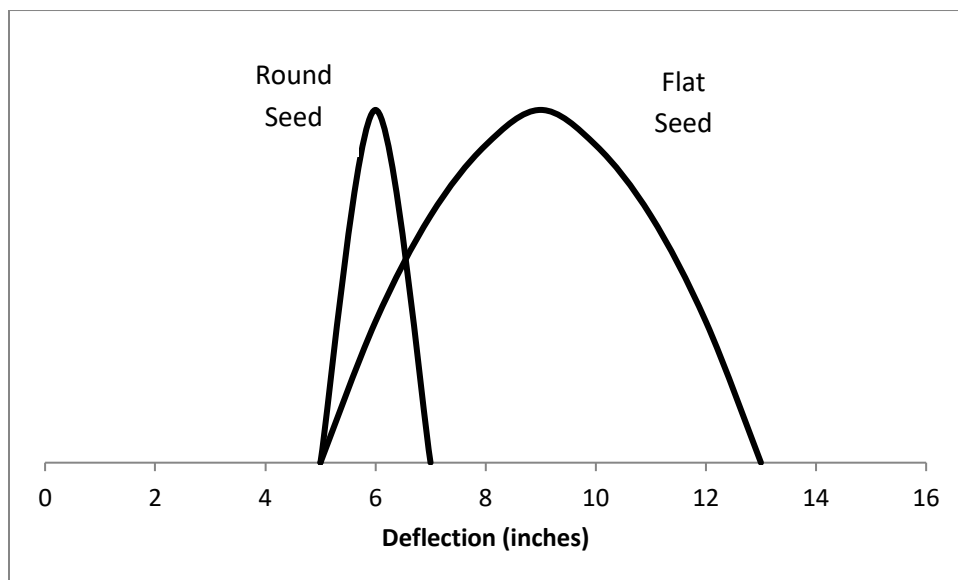
If we take our uniform collection of round seeds and smash them to form an equally uniform collection of flat seeds, then run them through the Wizard, we will find that the horizontal spread increases substantially. This occurs because a seed falling edge-on to the wind will be deflected less than a seed falling face-on to the wind; in effect aerodynamic density is now dependent on orientation.



Flat seed falling edge-on

Flat seed falling face-on

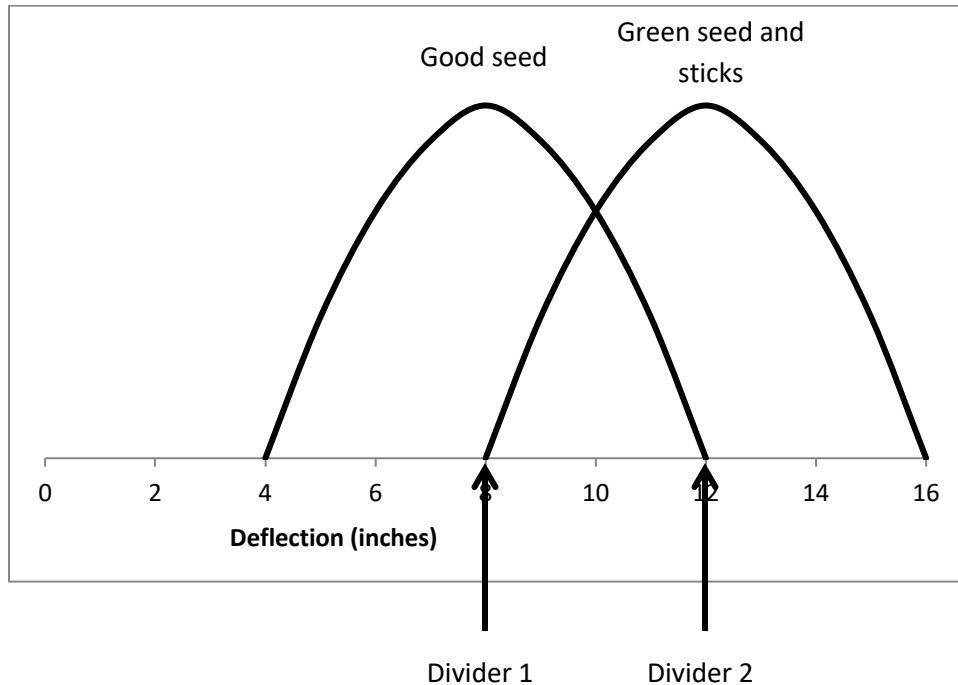
If we graph the spread curves of our round and flattened seeds, they will look something like this:



The important thing to note is that this spread is entirely random, as all of our flat seeds are identical. One particular flat seed may land at 6" in one pass, 12" in the next, and 9" in a third, depending on how it is oriented as it falls. The spread curve can be viewed equally as the positions at which 1000 identical seeds will fall, or the positions at which one single seed will fall if it is dropped 1000 times.

The challenge with winnowing flat seed is that the tail end of the spread – the seed that happens to fall face-on to the wind – overlaps with chaff, small sticks, and light seed. The solution is to take advantage of the fact that with enough passes, any given good seed will eventually fall edge-on and land closer in, while sticks and light seed will always be deflected past a certain point. This is the theoretical basis for the Wild Garden lettuce seed winnowing strategy, which has dramatically reduced the time required to clean lettuce – less screening – while also producing a cleaner finished seed.

The curves look something like this:



Using a narrow central bin and two dividers set at 8" and 12", we split the stream into three fractions. The close fraction is almost 100% good seed with no sticks. The farthest fraction is almost 100% light seed and sticks with no good seed. The middle fraction is a mix. The middle fraction is then re-winnowed, and the stream fractionates a second time along the same probability curves. With each pass, the volume of the middle shrinks by about 50%, and about 50% of the good seed in the middle falls in front of the first divider and is recovered. If we continue to re-winnow the middle five times, we can recover over 98% of the good seed while removing nearly all of the sticks and light seed.

# of passes	% of good seed recovered
1	50%
2	75%
3	87.5%
4	93.8%

5	96.9%
6	98.4%

In reality, there is usually less overlap than in the example, and it is sufficient to re-winnow the middle fraction 3-4 times. When the volume of the middle fraction is small and it appears to be mostly green seed and chaff, then we add it to the chaff bin and call it done.

### *Winnowing flat seeds with one divider*

One problem with using a two-divider system is that a few seeds (less than 1%) are unlucky enough to bounce off the top of the first divider, over the second, and into the trash bin. To avoid this, or to winnow lots that are too large for the narrow bin, we have often adopted a different strategy.

1. Set the divider at position 1 in the above diagram (at which 50-70% of the good seed stays in and all of the sticks/light seed winnow out). Winnow the whole lot, then re-run the light fraction, collecting the heavies in the same bin as before. Set these heavies aside as Lot 1 – this should be around 75-85% of the total seed.
2. Set the divider at position 2 in the diagram (at which everything that winnows out is trash) and winnow the “2x light” fraction. Discard the trash. Continue to the next step with the heavier fraction.
3. Set the divider back at position 1, or a little back from position 1 if you want to save lighter-or-smaller-but-still-good seed. Winnow the seed from Step 2, then re-winnow the light fraction 2-6 times until you are content to discard the remaining light fraction. The combined heavies from this step – usually 15-25% of the total seed – are Lot 2.
4. If necessary, perform additional screening/cleaning steps on Lot 2 until it is clean enough to combine with Lot 1.

## **Magnetic Dirt and Rock Removal (optional)**

### Notes:

- Magnetic properties of rocks and soils vary widely locally and regionally; while this has worked well in the Willamette Valley of Oregon I cannot attest that it will work as well elsewhere. If you use the dirt removal attachment please report on its efficacy in your area. Organic matter and debris (e.g. bird and rodent feces) are nonmagnetic and cannot be magnetically removed.
- Effectiveness decreases with increasing seed size, as slot width necessarily increases (some dirt falls farther from the magnets) and larger dirt clods are not as readily deflected. Only the most magnetic soils can be effectively removed from beans.
- Seed should be as clean as possible before this step, to optimize flow through a narrow slot.
- Winnow the seed first to remove very small dirt particles. If not removed this magnetic dust tends to collect on the magnet surface and reduce effectiveness.

### **Caution!**

**These neodymium magnets are extremely powerful and will attach to an iron/steel surface with a force exceeding 150 lbs, potentially causing finger pinching. Keep away from metal surfaces and loose metal e.g. nails and screws. Keep away from pacemakers, credit cards, and sensitive electronics. Do not attempt to separate the two stacked magnets. Magnets are brittle and may shatter explosively, ejecting sharp fragments at high velocity, if dropped or allowed to attract other strong magnets. Store in a dry sealed container. Magnets will eventually rust if stored in a humid environment.**

### Directions:

1. Remove the feed tray, turn off blower; no airflow required.
2. Remove the stainless steel hopper gate and replace with the magnetic gate.
3. Adjust magnets to approximately 1/8" from front edge of gate.
4. Set divider so that it shaves the rear edge of the seed stream, with 99+% of seed falling in front. This is typically around 7.5-8".
5. Open gate as little as possible so that a steady stream of seed falls. Dirt particles and rocks will be deflected toward the magnet and will fall behind the divider.
6. Adjust magnet forward or backward as necessary; periodically clean off dirt particles that adhere to magnet.
7. Repeat if necessary. With sufficiently magnetic soil each round removes ~75-90% of the dirt particles, and extremely dirty lots may require 3-4 passes.

Helpful tip: For larger seeds like peas and beans, use the wiggle wire on the hopper agitator to allow seeds to flow through a narrower slot. Plug it into the top unswitched outlet, and if necessary trim the wire so that it only protrudes ~1/4" through the gate and doesn't contact the magnet surface. The triangle twist attachment also works, but it tends to grind dirt into dust which then accumulates on the magnet, reducing effectiveness.

## **Troubleshooting**

### *Airflow decreasing*

Clean blower intakes and wind tunnel screens. Examine blower wheel blades and clean if necessary.

### *Airflow uneven left to right*

Clean blower intakes and wind tunnel screens. Use only screen combinations specified on p.7. Try other orientations of “S” screen. If persistent, dividers may be angled slightly to compensate.

### *Excessive blower noise*

Avoid using high blower speed with more than a single screen in place – and especially with partially obstructed screens. If rubbing/scraping noise, remove intake screen opposite motor and check blower wheel clearance. Adjust blower wheel on shaft (5/32” hex wrench) if necessary.

### *Excessive noise from feed tray*

Check vibration motor mounting bolts are secure and tight.

### *Excessive seed bounce*

When splitting excessively bouncy seeds (e.g. cilantro) into heavy and light fractions, it can be helpful to place a sheet of folded paper over the divider.

### *Excessive horizontal spread/poor separation precision*

Reduce feed tray angle to reduce bounce off of feed plate. Reduce slot size as small as possible. Reduce feed rate. If winnowing flat seeds, use probability-based winnowing strategies (pp. 12-14).

### *Too little vibration/seeds vibrate to one side of tray without falling off.*

1. Rotate eye screws to level tray and equalize tension in all four suspension cables.
2. Increase feed tray angle and/or decrease feed rate to reduce seed weight in tray.
3. Remove feed tray cover and ensure vibration mounting bolts are secure and tight.
4. If persistent, contact Mark Luterra or Oppen Works LLC

## **Replacement Parts**

Available online, or contact [sales@oppenworks.com](mailto:sales@oppenworks.com)

All other components: Contact [sales@oppenworks.com](mailto:sales@oppenworks.com)