Introduction for Grain Bikes

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Unlike some "hacks" for small farmers, the Grain Bikes don't solve an acknowledged problem so much as create new opportunities for small farmers. The grain bikes enable a small farm to dabble with growing dry beans, grain, and seeds. These three new products are non-perishable, can be sold, eaten, or planted to avoid seed costs (such as rye for cover crops), and, the labor for processing them can be shunted to the winter when more time is available.

In general, these plans do not provide instructions for safety features (cowlings, guards, goggles, respirators, etc.). It is the responsibility of each farmer to add safety features appropriate for their application and environment.

Since most small farms already own equipment for planting and cultivating dry beans and grains, the grain bikes make it possible to process these crops from dry material to finished product in about 1 minute per pound (per process). For example, dry beans or rye seed require only threshing and fanning, so that's 2 minutes per pound. Rice requires threshing, fanning, de-hulling, and re-fanning, so that's 4 minutes per pound. It makes sense for a farm to use slower, safer bike power while "proving" the process and the market for various crops. Later, as the market grows and greater efficiency is sought, the investment in faster equipment (or using electric motors instead of bikes) with more safety features is justified. The old bike powered equipment, having paid for itself, can be retired, passed on to a younger farmer, or stored for the kids to use at harvest festivals.

I have tried to make the design of these tools as adaptable as possible to various crops and conditions. Right away we learned that the behavior of dry beans on a dry week differs from that of the same beans after a humid week. So with the thresher, the swipples can be changed quickly, as can the screen. We have experimented with swipples made from bicycle spokes, chain (plastic and metal) and hardwood. With the fanning mill, different screen sizes, adjustable tilt angles of the screens, adjustable frequency and amplitude of the shaker, and adjustable speed of the blower are all possible. The de-huller is adjustable for different size grains, and adjustable for how hard the grains are abraided during de-hulling. In addition, the de-huller is convertible to a flour mill for making flour from grain. All of this adjustability comes at little cost and supports farmers who want to process a variety of crops for a variety of markets while getting the benefit of polyculture on their farm. In addition, adjustability makes it advantageous for more than one farm to share the equipment and grow different crops from eachother's , getting the benefit of sharing without the detriment of market competition.

There are two hidden costs not accounted for in these instructions. The first is that because the grain bikes are constructed from un-painted wood, they can't be left outside like some agricultural equipment. The grain machines must have an indoor location protected from rain and sun. The second hidden cost is that in order to dry the crops for processing (and in order to spend the least time harvesting during the high season), the farm needs a location to hang the drying plants-- either a garage, a barn, or an unused greenhouse. These "real estate" costs could easily overshadow the cost of the machines.

The total cost of the materials for the three grain bikes, the thresher, the fanning mill, and the de-huller, assuming the bike stuff is scavenged, is ~$600. The design uses wood and bicycle parts because they are cheap or free. Wherever bicycle parts are specified, regular shafts, bearings, and sprockets may be substituted. The transmission for the fanning mill blower relies on the discovery that 1/2" drive socket wrench sockets fit on most square-drive bottom bracket spindles. This allows the fabricator to make custom parts that remain centered (without machining) and bolt to a bicycle bottom bracket.

In addition to bicycle mechanics, the builder will need to weld. Since welding has to be done to minimize distortion (especially on centered parts like the blower transmission of the fanning mill), I recommend an electric welder such as MIG rather than an oxy-acetylene welder. If oxy-acetylene is used, than brazing instead of welding will result in less distortion.

A flat belt is used to drive the shaker mechanism on the fanning mill. Flat belts are cheap, low friction (compared to v-belts), and fun to use. Farmers used flat belts in the past, and may yet again in the future. There are a couple tricks to flat belts. First, the pulleys have to be crowned at the center. If your flat belt randomly jumps off one side or the other, crown your pulleys. To crown a pulley mount it on a bolt and chuck the bolt in a drill. Spin the pulley and hold it obliquely against a piece of sandpaper. Second, if the alignment of the two pulleys is off—by which I mean the two pulley axes are not parallel-- the flat belt will "climb to the higher side" and always fall off that side. Old leather belts work great as flat belts, and can be sewn, stapled, or glued with virtually any glue to make a belt out of a strip. Pulleys can be made in minutes from plywood, plastic, or wood sandwiched together to minimize splitting and warping. If you use a hole saw to make a pulley you get a center hole the size of the pilot bit for free. If the center hole needs to be countersunk (such as the shaker pulleys on the fanning mill), you may opt to countersink first and then hole saw the pulley out.

The blower on the fanning mill is designed to use a cantilever mounted bearing on a relatively sturdy drive side housing. This allows the light (non-drive side) cover of the blower housing to be removed and the apparatus cleaned and checked for interference, since the blower will still turn with the cover removed. This feature also allows access for cleaning and rodent and bug control.

When considering exercycles and bikes to use as power units for the grain bikes, any exercycle that uses bike parts will work. Flywheels are helpful, but make transporting the bike harder. Bicycles are more work to modify than exercycles, but make it possible to have higher quality components, gears, and a better power position. The thresher uses the most power and needs a high gear ratio ( ~ 1:4) in order to turn at 250rpm. In addition, the thresher should be a "fixed gear" so that the rider can turn the shaft both ways to clear the shaft should it get jammed with fibrous material. The fanning mill requires the least power and can have a single input gear with ~100 rpm. The fanning mill transmission allows the operator to select many possible gear combinations to tune the blower and shaker to the input power. The de-huller is fine without gears if used only for de-hulling, and also wants an input rpm in the ~100 rpm range. However, if the mill is going to be converted to a flour mill for making flour then I advise using a bike PTO with gears and a flywheel. Flour requires a lot of energy in a low speed high torque application of power. A flywheel makes a smooth pedaling motion possible and gears make it possible for young and old alike to make it work. We were tempted to use one deluxe bike PTO to power all four applications (thresher, fanning mill, de-huller, and flour mill) but because all the machines are used at the same time, too much time was lost switching the bike from one machine to the other and back again. It is an irony of our epoch that four bikes can be scavenged in less time than it takes to move one bike around.

Thanks mostly to a grant from NESARE ([www.nesare.org](http://www.nesare.org)) and help from others these instructions are offered free to everyone. The instructions can't be sold, however, individuals and small shops are encouraged to make and sell the machines. Farmers and tinkerers will be able to improve the performance, cost, and ease of construction of these machines to everyone's benefit. More experiments and creativity in swipple design, blower design, and de-hulling pads will yield grain. Please share your improvements on this website!

Finally, in addition to thanking NESARE for the bulk of the grant money [$13,742] , I would like to thank the other individuals who donated money and priceless time to help: Bill Braun (Ivory Silo Farm) paid for half [$2000] of the original prototyping and provided the inspiration. Steve Baer (Zomeworks Corp.) donated money [$400] and expertise. John York did the calculations for the blower on the fanning mill and consulted on innumerable other technical details. Peter Dow drove down from New Hampshire to solve a problem with the de-huller. Josephine D'urso interned here in June, completed countless shop tasks and designed and built the tipping bucket for the fanning mill and the cowling for the de-huller (with the volunteer help of Kenneth Ferro). Emily Vogler and Olaf Bertram-Nothnagel, in addition to agreeing to work for pay, also poured uncompensated effort and intellect into each stage of the project.  An anonymous scrap monger saves discarded bikes and excercycles for me. And all of the crops for testing the machines were grown by Chris Yoder (Vanguarden CSA), Hannah and Ben Wolbach (Skinnydip Farm), Noah Kellerman (Alprilla Farm),  and Dee Levanti and Bill Braun (Ivory Silo Farm).