

Project Documentation



Precision Planter

Prototype Summaries, How To Build, Next Steps

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Prototype 1

Designed and constructed during IDDS 2015 in D'Kar, Botswana.

A 25mm 90cm long square tube is pushed into the ground using a foot pedal. The end of the tube features a pyramid point that punctures the ground to create a hole for seed dispensing. The tip of the planter is hinged on the end of the tube. A wood dowel is situated inside the main tube, protruding from the top of the tube. By pushing down on the dowel with the thumb, the hinged tip opens, allowing seed and fertilizer to fall through. The seed and fertilizer containers are attached to a u-joint with a thumb hole at the top of the square tubing. By moving the thumb back and forth between the sides of the u-joint, specified amounts of seed and fertilizer are released down the tube and into the soil. The planter must be raised out of the soil to allow for clearance for the hinged tip to open.

Prototype 2

Initial prototype ideas from UC Davis D-lab March-August 2017. Designed and constructed by Mathambo Ngakaeaja, Stephanie Lew and Alex Wilder in D'Kar, Botswana, 2017.

Planter and dispenser designs were evaluated and discussed with DKIC members, and the spade planter and slider dispenser were chosen. The planter features 2 25mm 90cm square tubes, to dispense seed and fertilizer separately, 5cm apart. 2 flat bar angled spades are attached to the end of the tubes, with a foot pedal attached above the spades. Circular tube handles are placed on the planter below the dispenser. The dispenser sits atop the tubes, featuring an offset-hole system. Using 3 plates, the middle slider collects a specific amount of seed and fertilizer. A sliding action moves the amounts down the appropriate tube. Metal handles on the slider control its motion to the dispensing limits. Water bottles are fixed to the top plate with hot glue, holding a small amount of seed and fertilizer. Egg carton funnels under the top plate move the seed and fertilizer into the slider holes from the bottles. The planter is used by pushing the spades into the ground and rocking the planter to create 2 holes. By moving the slider, seed and fertilizer is dispensed. The holes are then covered with the foot.



Prototype 3

Changes to the prototype incorporated feedback from 27 farmers in D'Kar, Botswana. Problems encountered included: 0 seed dispersal, small capacity of seed and fertilizer, spillage of seeds, low durability of planter, low hand control, dirt clogging in pipes, and low depth control. The egg cartons were cut with a larger hole, which reduced the cases of 0 seed dispersal. Larger soda bottles replaced the half water bottles for seed and fertilizer storage. Lids with metal closing rods were added to keep the seed dry. The wood components of the dispenser were coated in varnish to protect against water damage and spillage. The egg carton funnels were replaced with flexible plastic sewn together, with the addition of cut strips to ensure that seed does not get stuck between the funnel and the slider. The water bottles were attached using a plastic clamp screwed into the top plate. The handle's side was switched to improve ergonomics, and handle extensions were attached perpendicularly to the handles, allowing for 2 types of holding. The ends of the 2 main tubes were shortened to prevent the tips from clogging with dirt from the planter's motion. An adjustable bolt on the spade allows for depth control of the planter, for planting different types of crops. The planter was then painted Botswanan blue.



How To Use The Planter

Counterclockwise from left.

Insert the spades into the ground at an angle.

Pivot the planter upright, opening holes in the ground.

Move the slider back and forth to dispense seed and fertilizer.

How to Build

Planter Base

2 – 85cm long, 25mm square tubes
2 – 4cm long, 25mm square tubes
215mm long, 4mm thick flat bar
190mm long, 4mm thick flat bar
M8, 6cm long bolt and nut
20cm by 8.5cm, 1mm thick flat bar

The 4cm pieces are grinded on the corners, narrowing the piece into a funnel shape. These pieces are then welded to the bottom of the 85cm long pieces. The 85cm long pieces are spaced 25mm apart. Both of the flat bars are cut at an angle to where one end is 15mm. Each flat bar is welded to the bottom of an 85cm long piece on the backside of the tube, with the longer bar attached to the left tube. They are oriented so that the 15mm end is situated directly below the 85cm tube opening, with the angled ends of the flat bar facing outward. 5cm of the top of the 4mm flat bar overlaps with the 85cm tubes for welding. From the bottom end of the seed flat bar spade, holes are drilled every 2cm until 8cm is reached. The M8 bolt is inserted into



the chosen hole to mark depth. The 1mm thick flat bar is centered and welded to the top of the 85cm tubes, with 25mm square holes cut out of the plate to coincide with the 85cm tube openings. 4 M8 holes are drilled into the flat plate, one at each corner.

Foot Pedal

30cm long, 25mm square tube

The tube is centered horizontally on the 2 85cm long pipes, 12cm above from the bottom of the 85cm tubes, and welded to the backside of the pipes.



Handle

30cm long, 25mm circular tube
2 - 15cm long, 25mm circular tubes

The 30cm piece is centered horizontally on the pipes, 9cm down from the top of the 85cm pipes and welded to the front side of the pipes. The ends of the circular pipe, as well as one end of each of the 15cm long circular pieces, are cut at a 45-degree angle. The 45 degree angled pieces are welded horizontally but perpendicularly to the 30cm circular tube, facing toward the front.



Dispenser

2 - 20cm by 8.5cm, 7mm thick cutting boards
4 - M8 bolts, 6cm long, with nuts
4 - 10mm circular plastic tube, 22mm long
Hot glue - gun and sticks
2 - 9cm by 18mm, 1mm thick cone-cut pieces of plastic/canvas
Needle and thread, 1m length

Both of the 7mm thick cutting boards are lined up with the 1mm flat bar at the top of the planter. 4 M8 sized holes are drilled through each of the cutting boards, lined up with those from the flat bar. One cutting board piece (bottom plate) has 25mm diameter holes drilled through it, matching up with the 2 pipe holes from the flat

bar. The other cutting board (top plate) has 2 25mm diameter holes drilled through it, but offset to the left laterally by 25mm, so the holes are offset. The 2 plastic pieces are rolled into a cone shape that is 18mm tall, with the larger end of the cone being 25mm in diameter. The plastic is sewn into the cone shape with thread, and slits are cut at the smaller end of the cones, at 3mm length. The cones are hot glued to the underside of the top plate, where the larger end of the cone matches with the holes in the top plate. The M8 bolts are placed through the holes of the top plate, bottom plate and the flat bar on the planter. The 10mm plastic tube pieces are placed in-between the top and bottom plate, to serve as spacers.



Slider

- 36cm by 4.5cm, 7mm thick wood plank
- 2 - 2cm screws
- 2 - 2cm by 1.5cm by 5cm wood blocks

Along the wood plank, centered holes are drilled. From the right end reference, a 5mm hole is drilled 48mm away, a 18mm hole is drilled 145mm away, a 10mm hole is drilled 215mm away, and a 5mm hole is drilled 292mm away. The wood plank is then slid between the plastic cones and the bottom plate cutting board, situated in-between the plastic tube spacers. The wood blocks are placed on the underside of the wood plank, and the screws are put through the wood plank's 5mm hole and the wood block, with the block's 5cm by 2cm face centered. The blocks should be lined with the 5cm dimension parallel to the 4.5cm dimension of the wood plank.



Bottles

- 2 – 700 mL soda bottles, not more than 50mm in diameter
- 2 – 1mm, 12cm long metal wire
- 8 – 1cm long wood screws
- 2 – 50mm diameter pipe vault chamber plates

The chamber plates have 26mm holes drilled through them, centered. The plates are then cut in half with scissors and trimmed to fit around the lip of the bottles. 2mm pilot holes are drilled through the plates and the top plate of the dispenser, centered on the top plate's holes. The portion of the bottles from the lip to the mouth is cut off with a hacksaw. The bottles are placed upside down over the top plate holes, and the chamber plate halves are placed on top of the bottle lips. The 1cm screws are then screwed through the plates, locking the bottles in place. The ends of the bottles are cut off with a utility knife, and placed upside down on the new bottle opening. Holes are punctured through the overlap between the overturned bottle ends and the main bottle. The 1mm wire is then placed through the overlap holes in 2 places, securing the new lids on the overturned bottles.



Next Steps

Next steps include thorough testing of the design under accurate farming conditions. At the first rain, portions that need to be tested, and potentially improved in the next prototype, include the following below.

- Adjustable bolt for depth control – determine whether accurate at multiple depths
- Wood slider – determine if prevents water damage
- Stoppers – determine if small wood pieces are durable under water, and hold up under force of slider motion
- Bottle clamps – determine if durable in holding bottles in place
- Bottles – determine if large enough capacity for farmer
- Height and weight – determine if appropriate for all farmers over extended use

Funnels – determine if durable and prevent clogging

Optimal corn and fertilizer amounts needs to be determined through field trials, with slider holes adapted accordingly. A slider for beans needs to be determined, optimized through field trials to 2-3 beans approximately.

The business model will be implemented for local and wholesale markets, using both sale and rental methods in D'Kar.

After the first rain, seeds will need to be inspected for germination and proper growth as a result of accurate use of the precision planter.