

Internship at PG Agri, Mumbai

Product Design
Project-1

By: Maddu Shravan Murali
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Masters in Industrial Design



IDC School of Design
अभिकल्प विद्यालय

IDC School of Design
Indian Institute of Technology, Bombay

1.0 About the company



The company basically provides agricultural equipments to the local farmers at a subsidised rate as prescribed by the Indian Govt. They have an overall of 7 centres in places like **Shimoga, Dharwad** and **uttar(North) Karnataka** districts.

N Anujay Rao, is the Co-Founder and Head of Project/Design of the company.
He has worked with Toyota R&D engine dept. in Japan HQ.

1.1 Present automatic equipment in the market

Seed Cum Fertilizer Drill Machine

Rs. 15,000/ Piece

Sujaram Hariram Trolley Works | Nagaur, Rajasthan



Automatic Seed Drill Machine

Rs. 52,000/ Unit

Avishkar Agribiz Private Limited | Rajkot, Gujarat



Seed Cum Fertilizer Drill

Rs. 45,000/ Piece

Atharva Agro Organics | Indore, Madhya Pradesh



Zero Till Seed Cum Fertilizer Drill

Rs. 40,000/ Piece(s)

Bharat Industries | Karnal, Haryana



Seed Drill Machine

R.G. Steel Crafts

| Indore, Madhya Pradesh



Seed Drill

Rs. 42,500/ Set(s)

Bharat Steel Works | Ahmedabad, Gujarat



1.2 What actually happens on the field



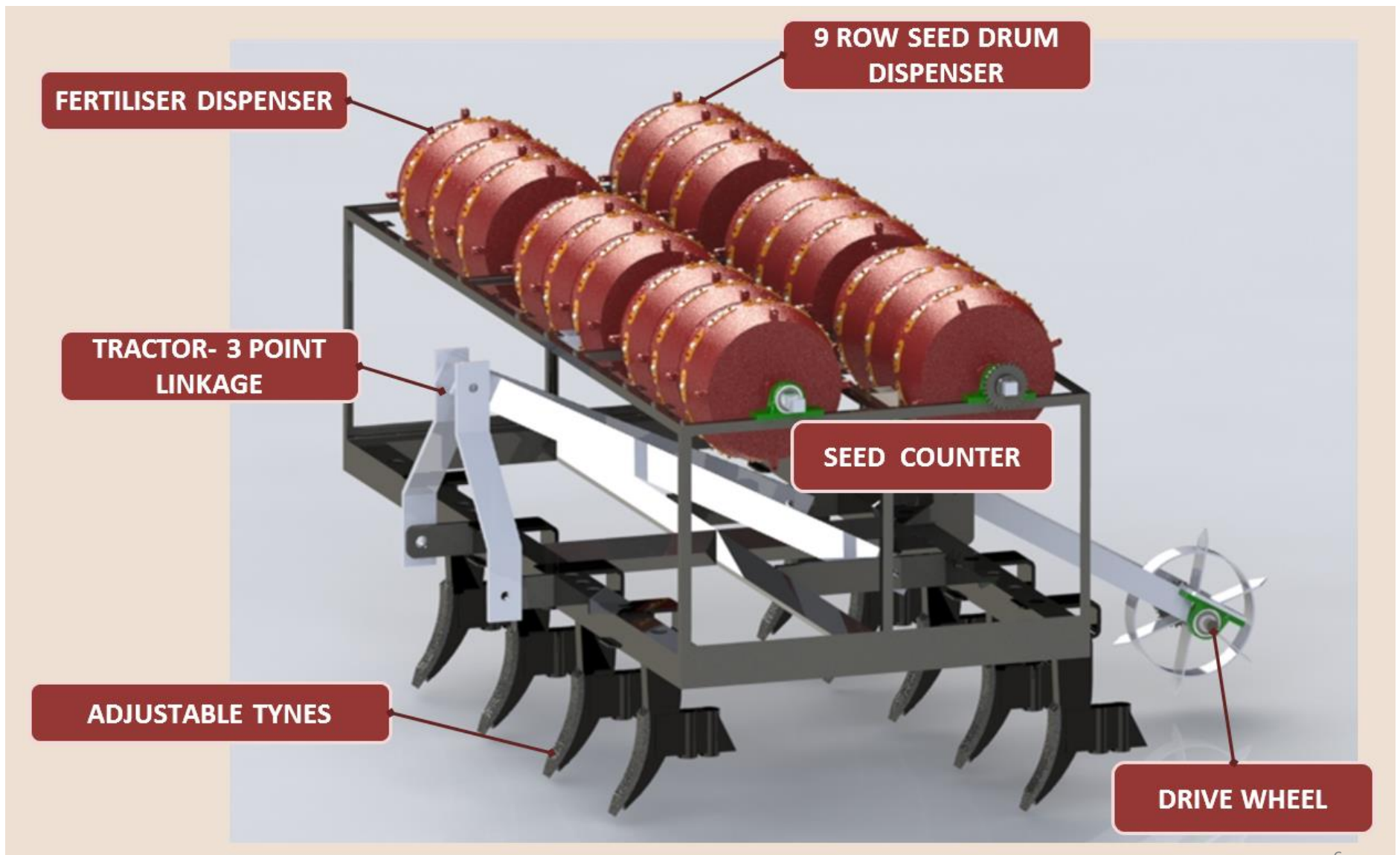
1.3 Observations

- 1 Due to inaccuracy in sowing, farmers are forced to stop tractors and unearth the ground to check if seed has fallen or not.
- 2 An extra labour is required to walk behind the equipment to check if the mechanisms are working in proper order.
- 3 Farmers purchase seeds in 5KG or 10KG allocated bags, but fertiliser consumption is calculated based on Plant Population. This means farmers have to guesstimate the number of seeds sown and then purchase fertilizers accordingly.

1.4 Proposed Solutions

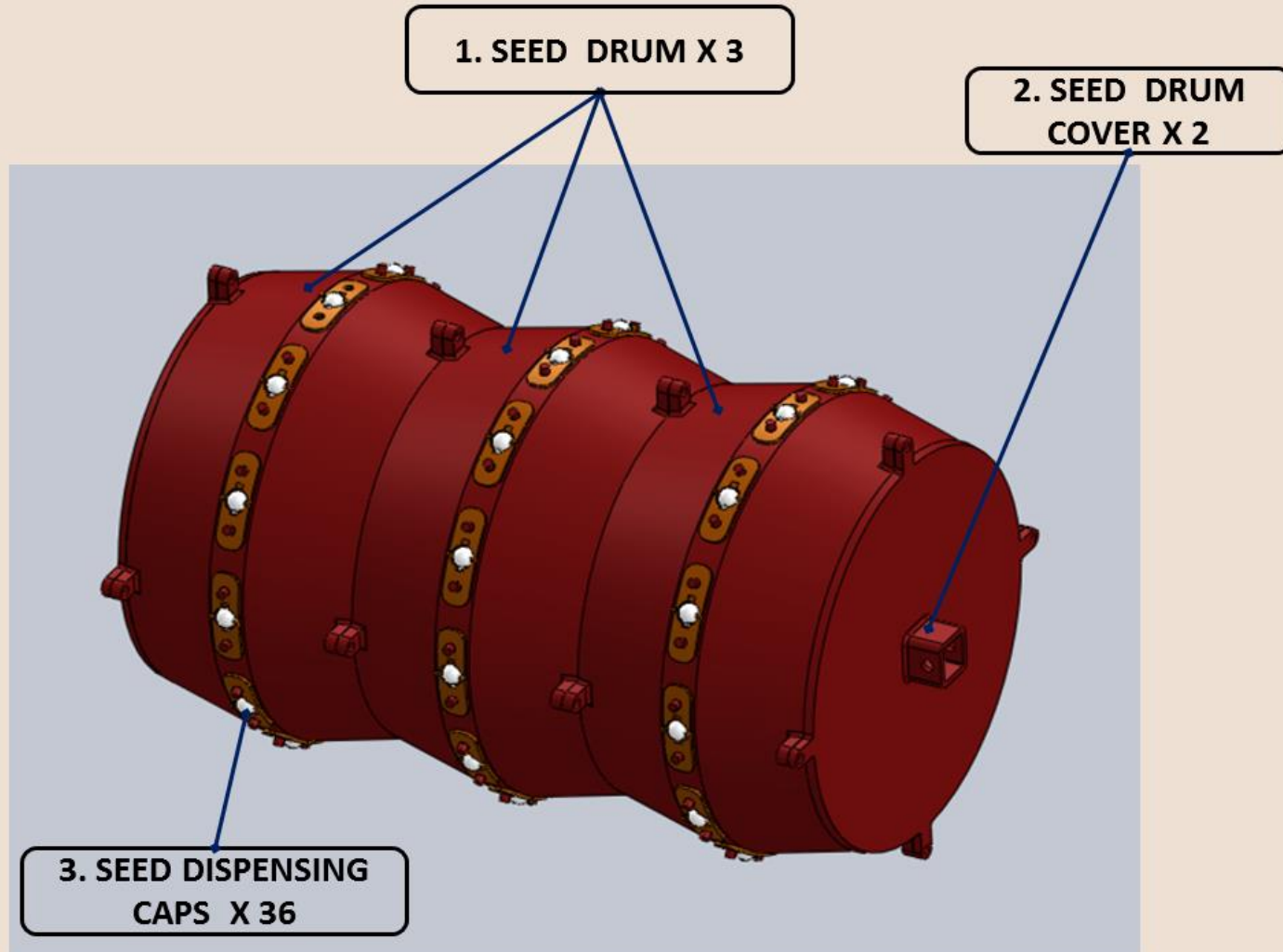
- 1 An equipment is required which not just sows seeds efficiently but also keeps an account of the number of seeds being dropped.
- 2 A user friendly feed back system between the user and the equipment which notifies the driver whenever a seed has not been dropped. Thus eliminating the requirement of a helper.
- 3 There are numerous advantages of knowing the Plant population. The number can be helpful in calculating
 - Yield expectation.
 - Help the farmer plan his financial movements ahead of time.
 - Removes the process of 'guesstimation' from to prevent losses.

1.5 Seed drill designed by PG Agri



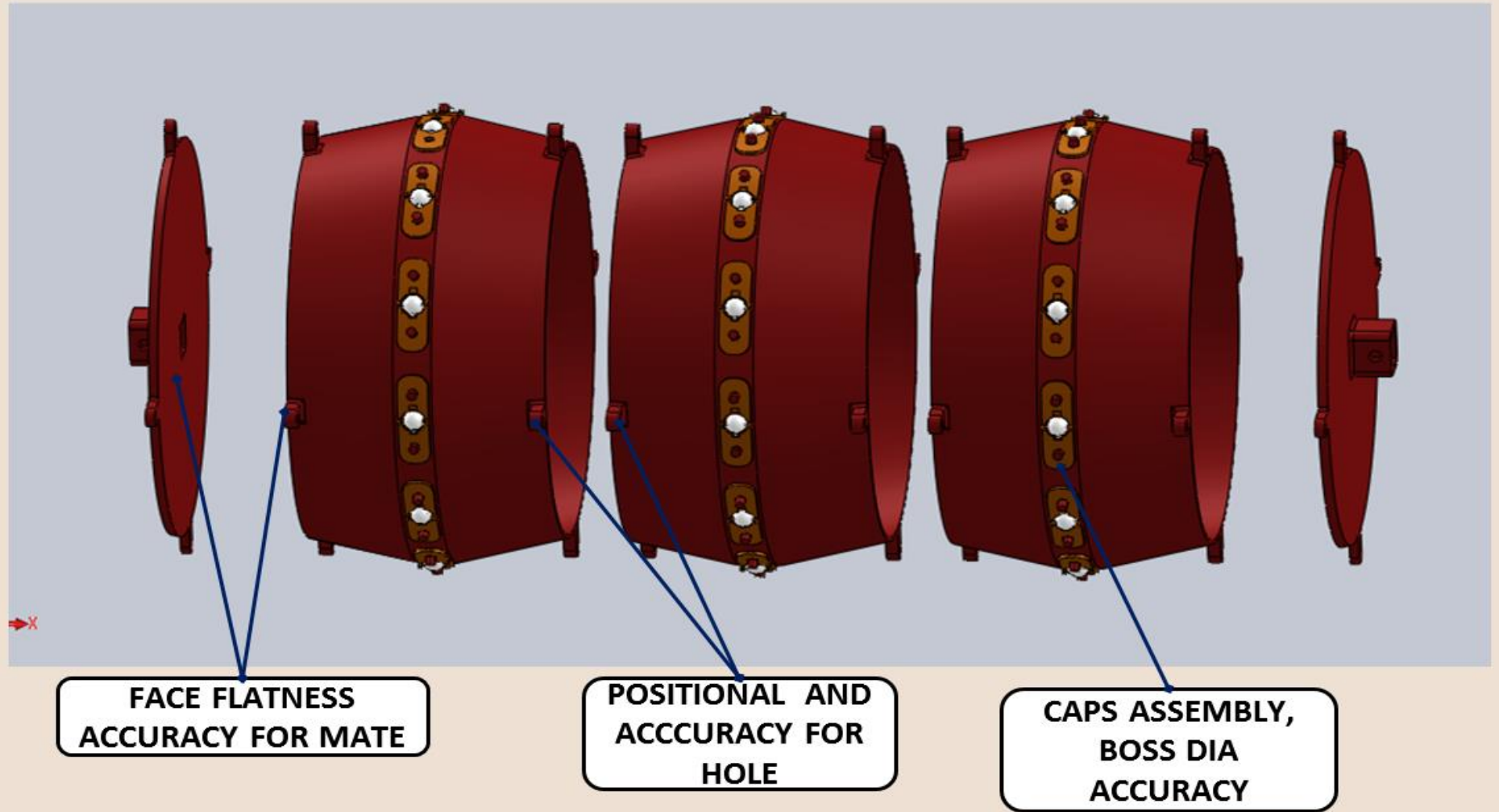
1.6 Drum Stack unit

WORKING ASSEMBLY 1 : SEED DRUM + CAPS



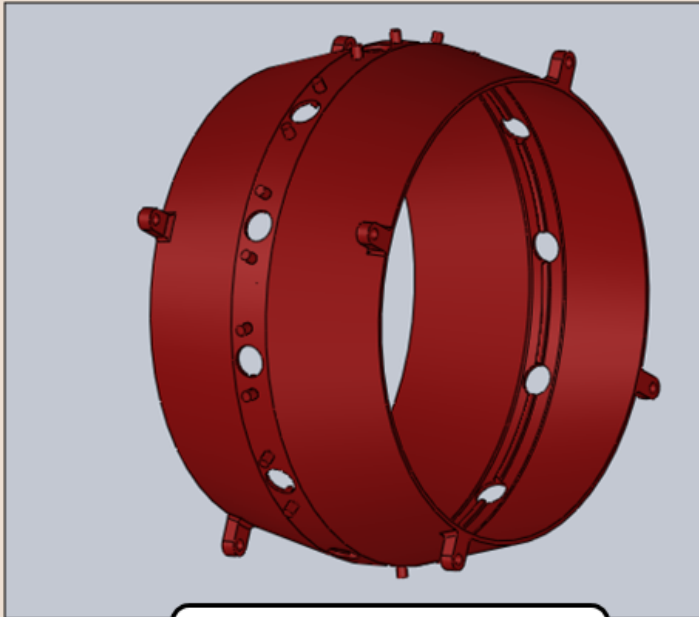
1.7 Drum Stack unit (exploded view)

WORKING ASSEMBLY 1 : MATING PARTS AND CRITICAL DIMENSIONS

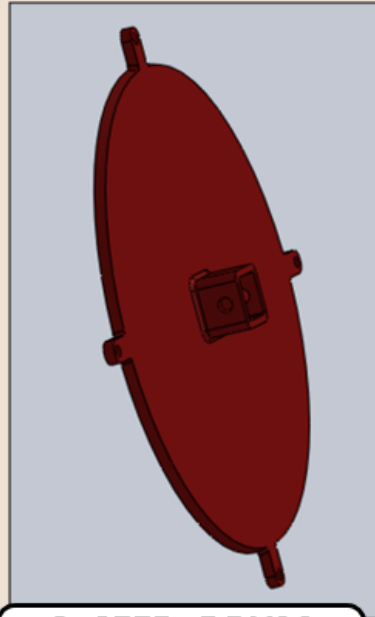


1.8 Seed drum and cap

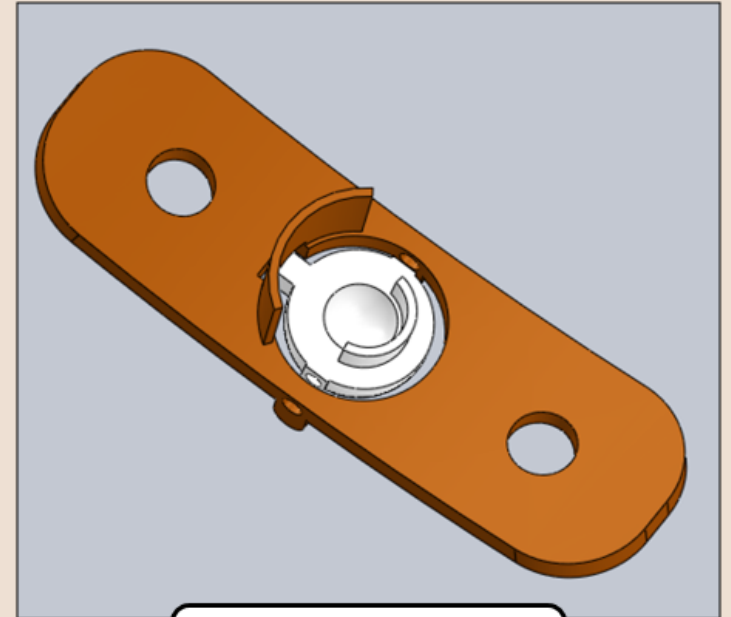
WORKING ASSEMBLY 1 : SEED DRUM + CAPS



1. SEED DRUM X 3



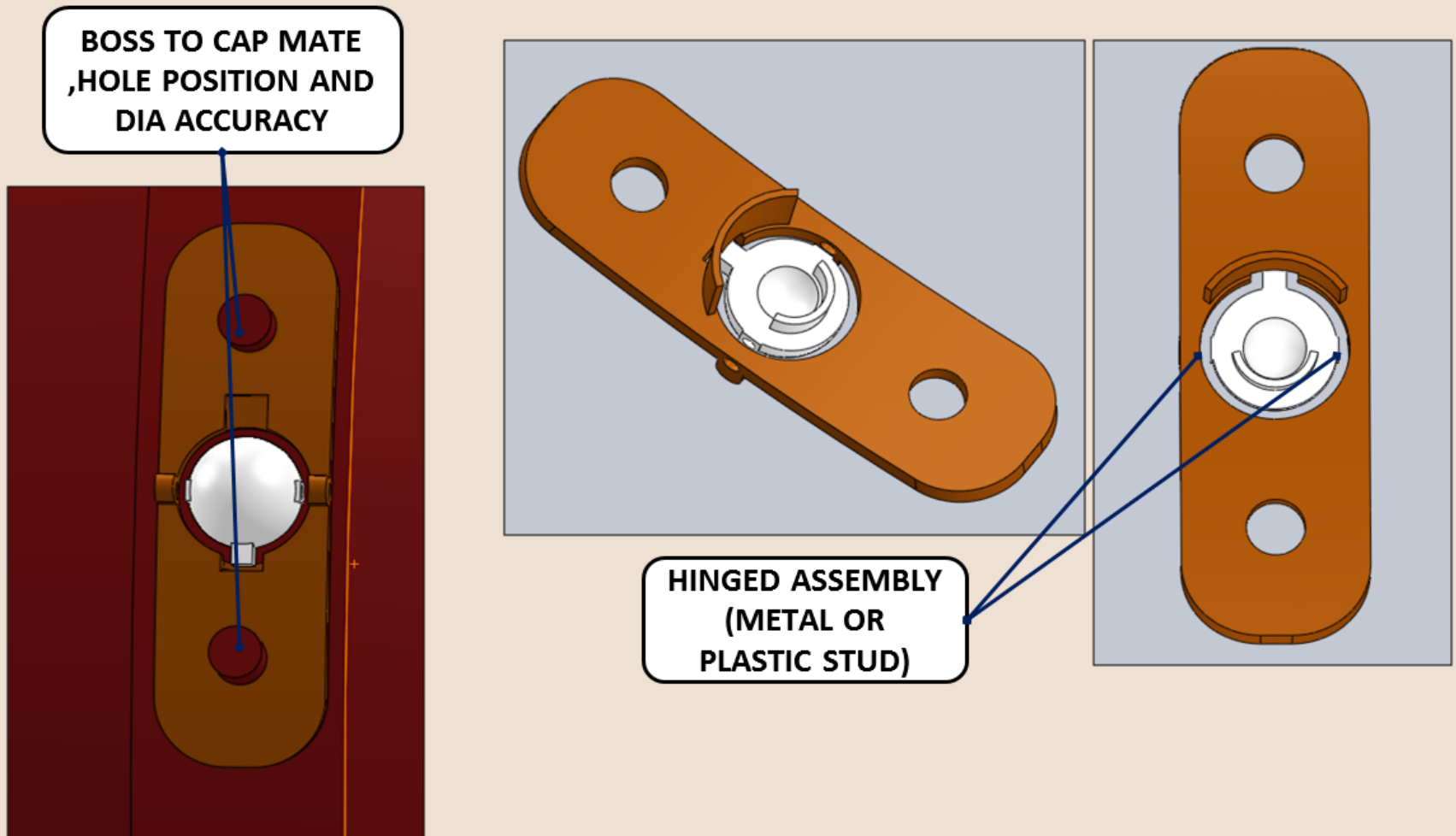
**2. SEED DRUM
COVER X 2**



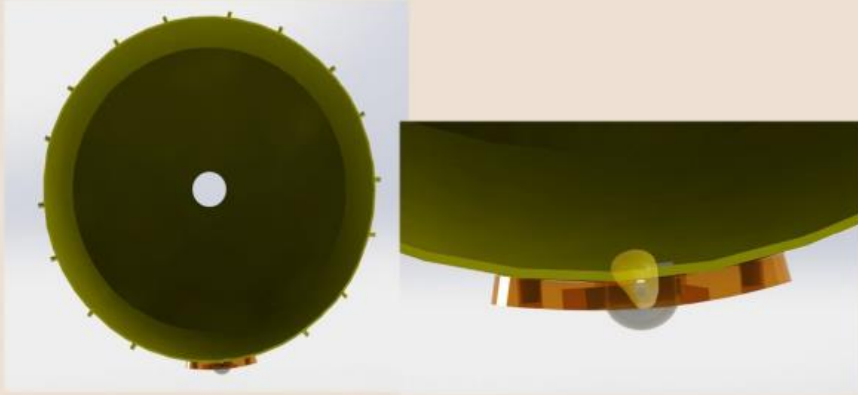
3. SEED CAPS X 27

1.9 Cap details

WORKING ASSEMBLY 1 : MATING PARTS AND CRITICAL DIMENSIONS



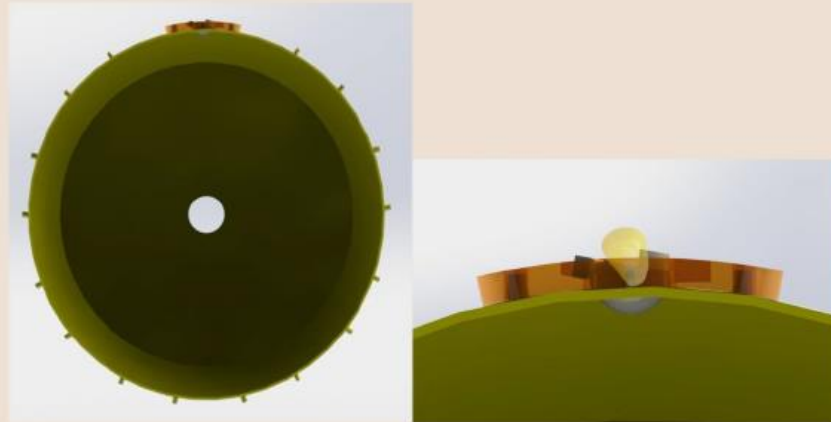
1.10 Cap mechanism and its working



Step 1 : When cap is in bottom position, a single seed is picked up by the cup.



Step 2 : As the drum rotates (anti clockwise) ,the seed is isolated by the cap mechanism.



Step 3 : The seed travels to the top of the drum.



Step 4 : Seed is dropped into the indicator + counter, and the cycle starts all over again.

2.0 Scope of the work

- To improve the mechanism of the cap after rapid prototyping and testing
- To design the cap according to chickpeas (*chana*) or soya
- To Build the test rig on which the prototypes are to be tested

3.0 Limitations of the work

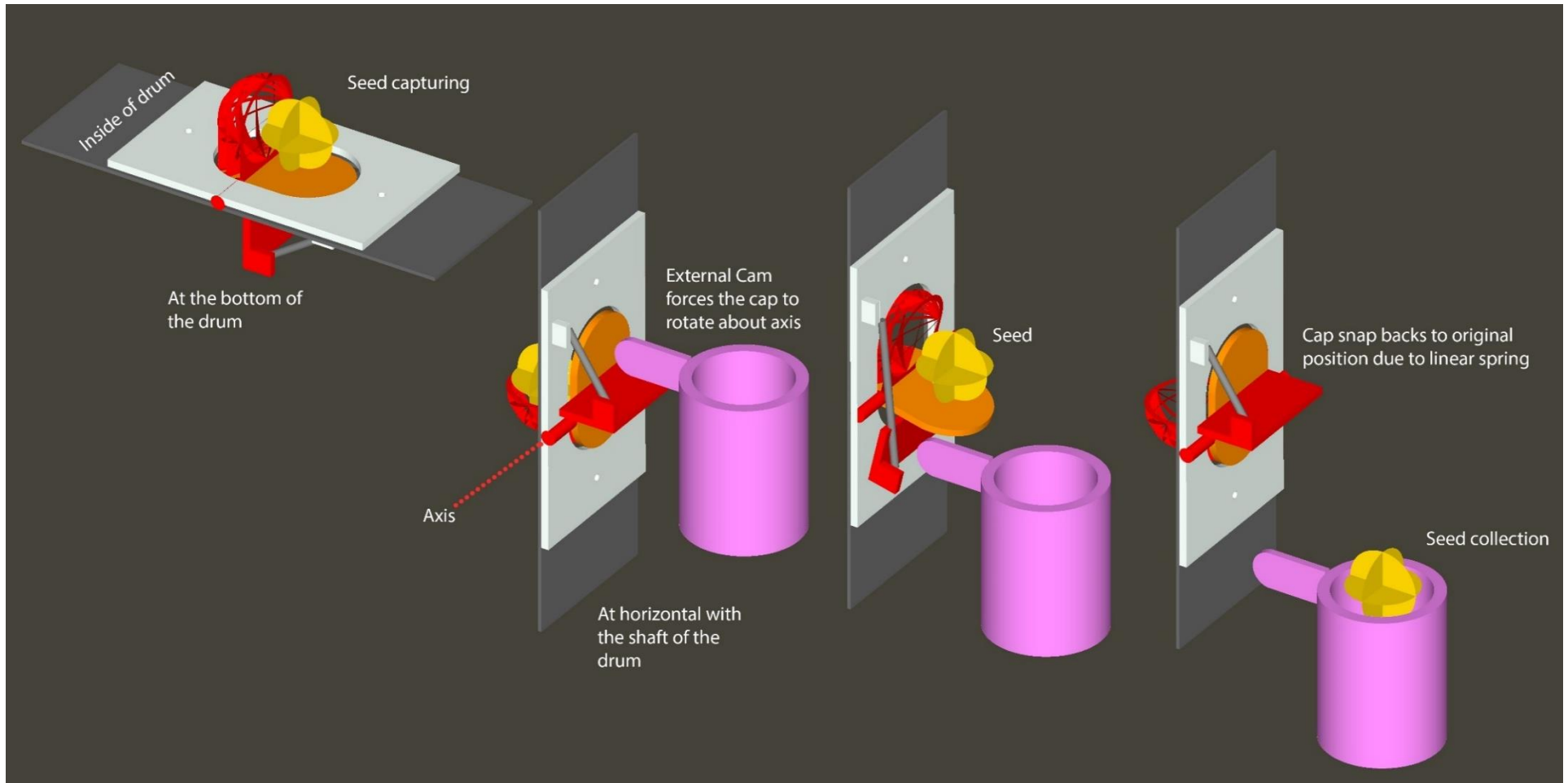
- Since the drum is already designed the perimeter needs to be kept constant (i.e. 380mm dia)
- The assembly details cannot be changed
- The overall framework of the equipment cannot be changed

4.0 Analysis of PG Agri's cap mechanism

- The hinge mechanism is prone to dust hence jamming can occur
- The cap may not rotate when the drum is filled of seeds
- It is difficult to determine where the seed will drop
- The seed is exposed to external forces like strong winds, vibrations from the tractor, etc.
- The seed has to travel about $3/4^{\text{th}}$ along the perimeter of the drum before the drop
- Gravity has a major role in the process

4.1 Possible solution

A possible cam mechanism was conceptualised where the spring loaded cap would be forced open allowing the seed to drop out of the drum



Conceptual illustration

4.2 Advantages of the proposed mechanism

- Probability of jamming is reduced
- The cap will rotate even when the drum is full of seeds
- Has fixed drop point
- The seed is protected from external forces like strong winds, vibrations from the tractor, etc.
- The seed has to travel only $1/4^{\text{th}}$ the perimeter of the drum
- Gravity has no more role in the process

5.0 Making a quick and dirty mock-up drum

A quick and dirty mock up the drum was made to test the new cap designs

The purpose of this prototype was to simulate the central rib of the proposed drum.

One face of the prototype is made of transparent acrylic sheet of 3mm to provided a visual feedback while testing out the new cap design.



6.0 Prototype 1 (Rapid prototyping)

A dirty prototype of the cap was made out of styrene. The cap did not have any lever to rub against the cam.

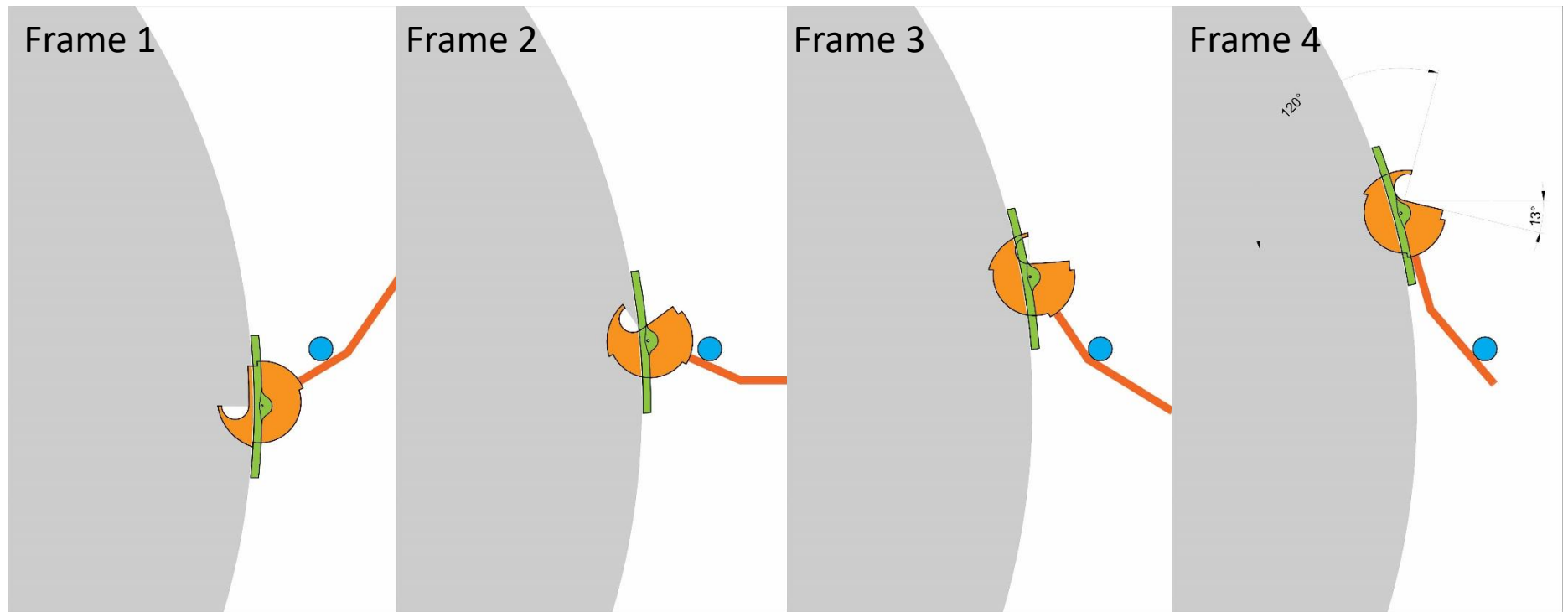
Observations

- Seed capturing is successful
- The spring used is torsion (also used in hair clip)
- Lever mechanism not present



Prototype 1

6.1 Determine the shape of lever 1 (movement analysis)



Resolution: 5 degrees

Observations

- Cam is long to provide the slope (20 degrees) needed for the seed to roll
- The torsion spring moves about 120 degrees

6.2 Prototype 2

The lever was designed onto the cap. The cam was kept simple at first.

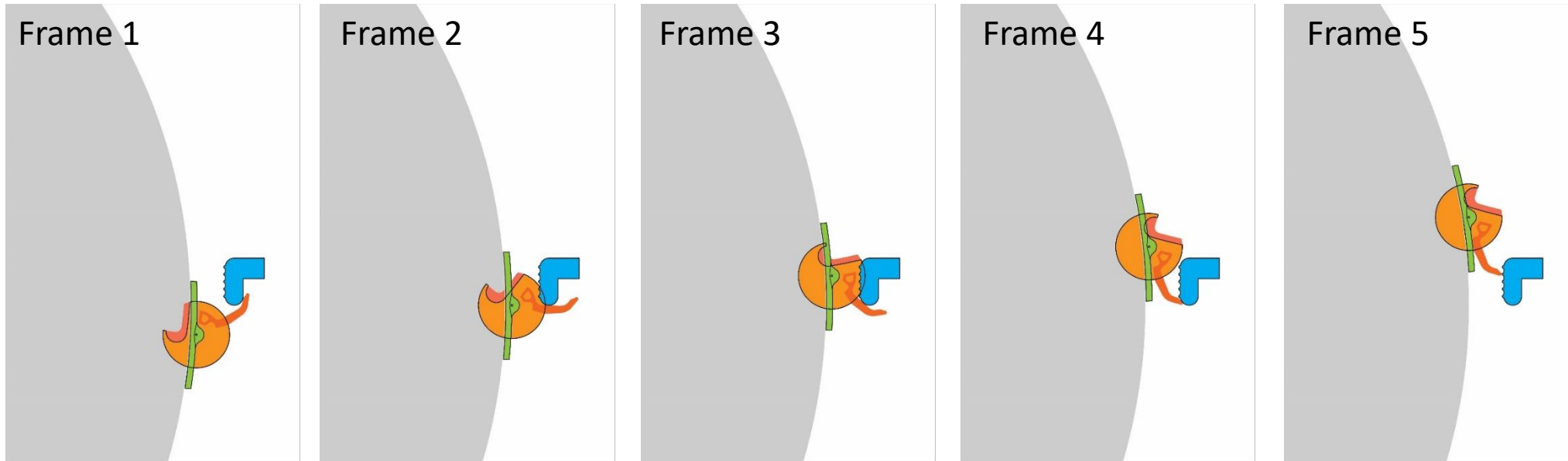


Cap and cap base with lever on both sides



Cap when mounted on the drum

6.3 Determining the shape of lever 2 (movement analysis)



Resolution: 3 degrees

Observations

- Seed capturing is good
- Needs strong axle
- Not enough time for seed to roll out
- The cap lever and the cam needs better form to provide delayed release
- The cap is tending towards one side

Solutions

Give strong axle
Give longer cam
Resolve initial contact point
Give lever on one side

6.4 Prototype 3

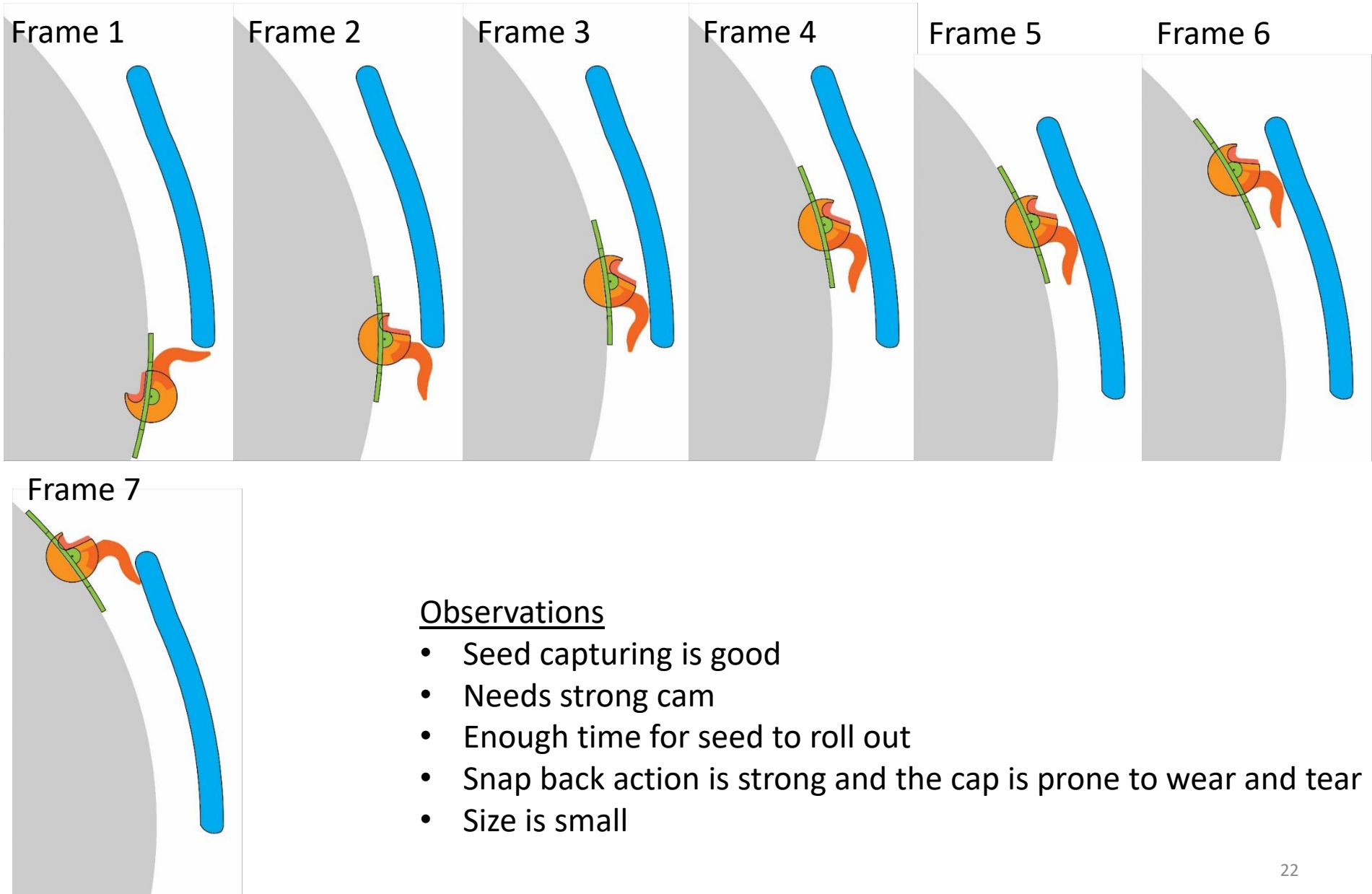


Cap and cap base with lever on one sides



Cap when mounted on the drum

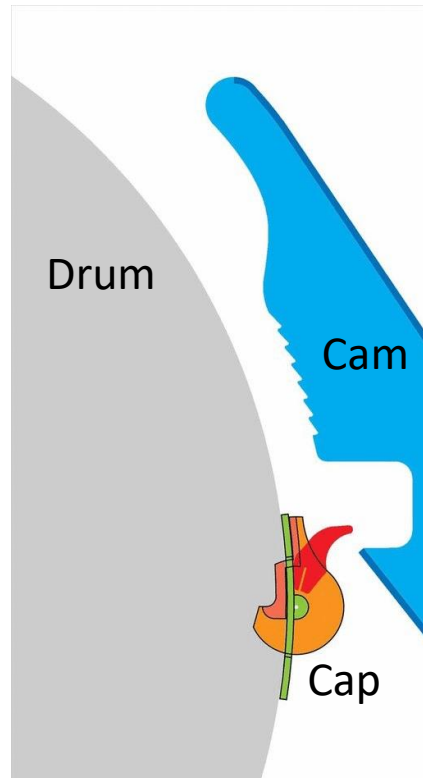
6.5 Determine the shape of lever 3 (movement analysis)



6.6 Prototype 4



Cap and cap base with lever on one sides on 1:1 3D printed PG Agri designed seed drum



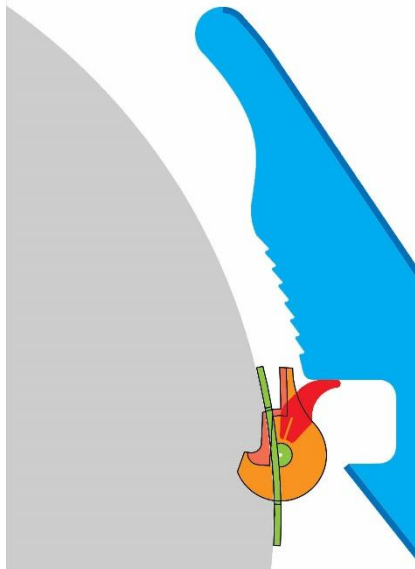
Illustrated section



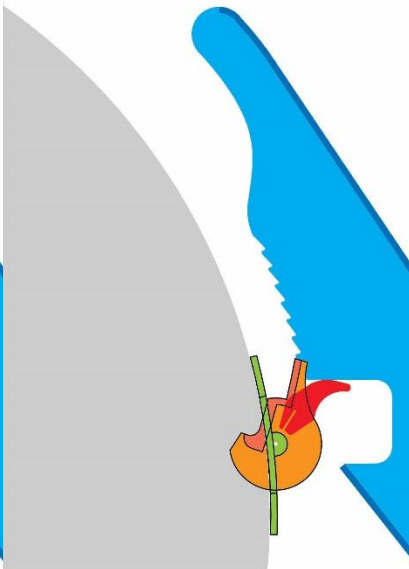
3D printed seed drum with acrylic lids

6.7 Determine the shape of lever 4 (movement analysis)

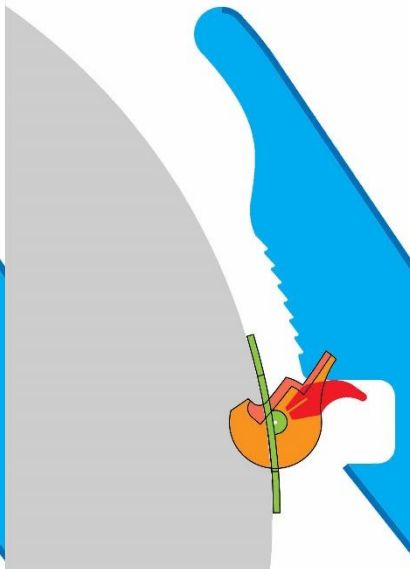
Frame 1



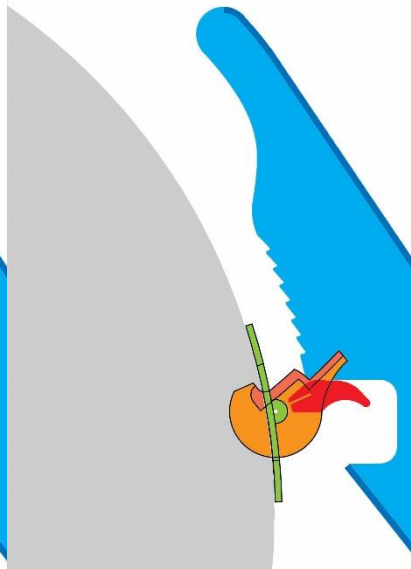
Frame 2



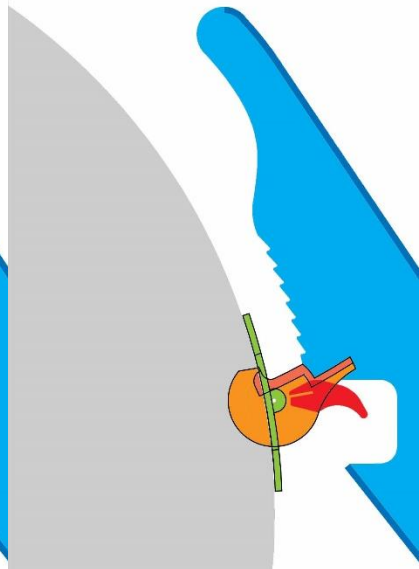
Frame 3



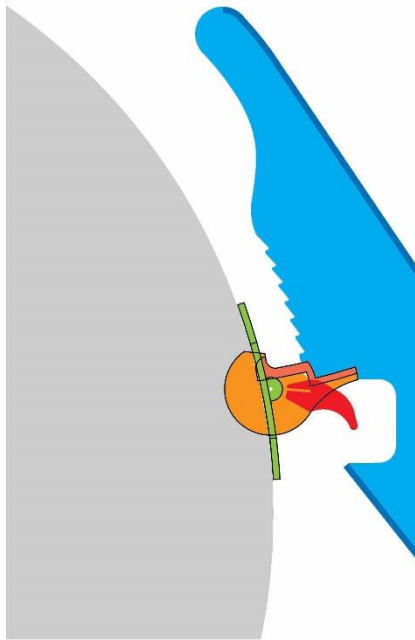
Frame 4



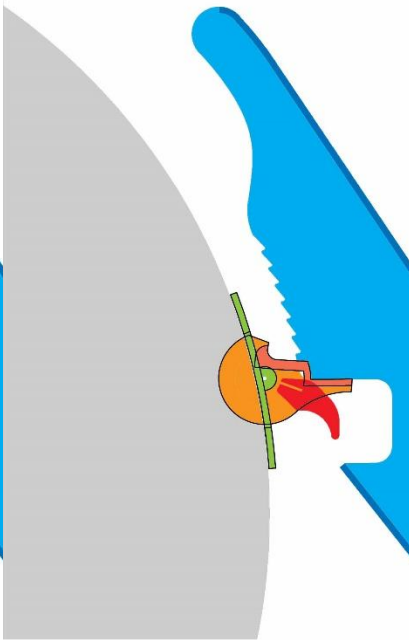
Frame 5



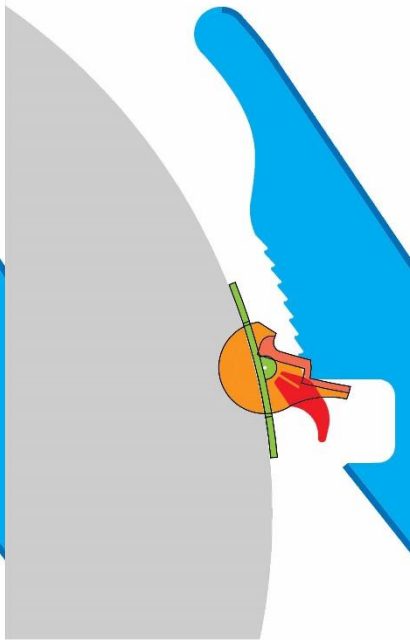
Frame 6



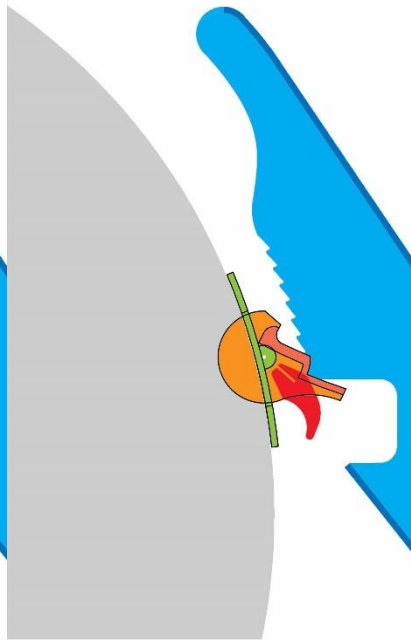
Frame 7



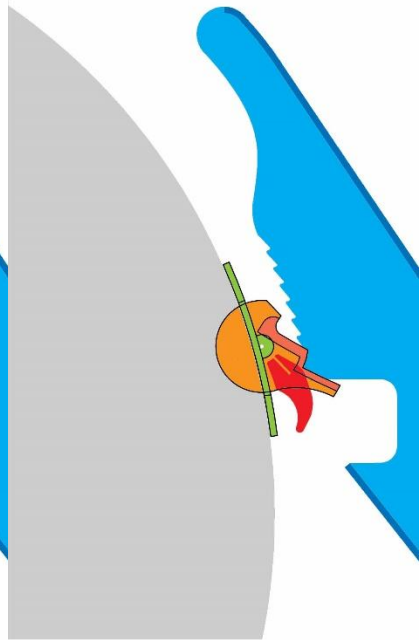
Frame 8



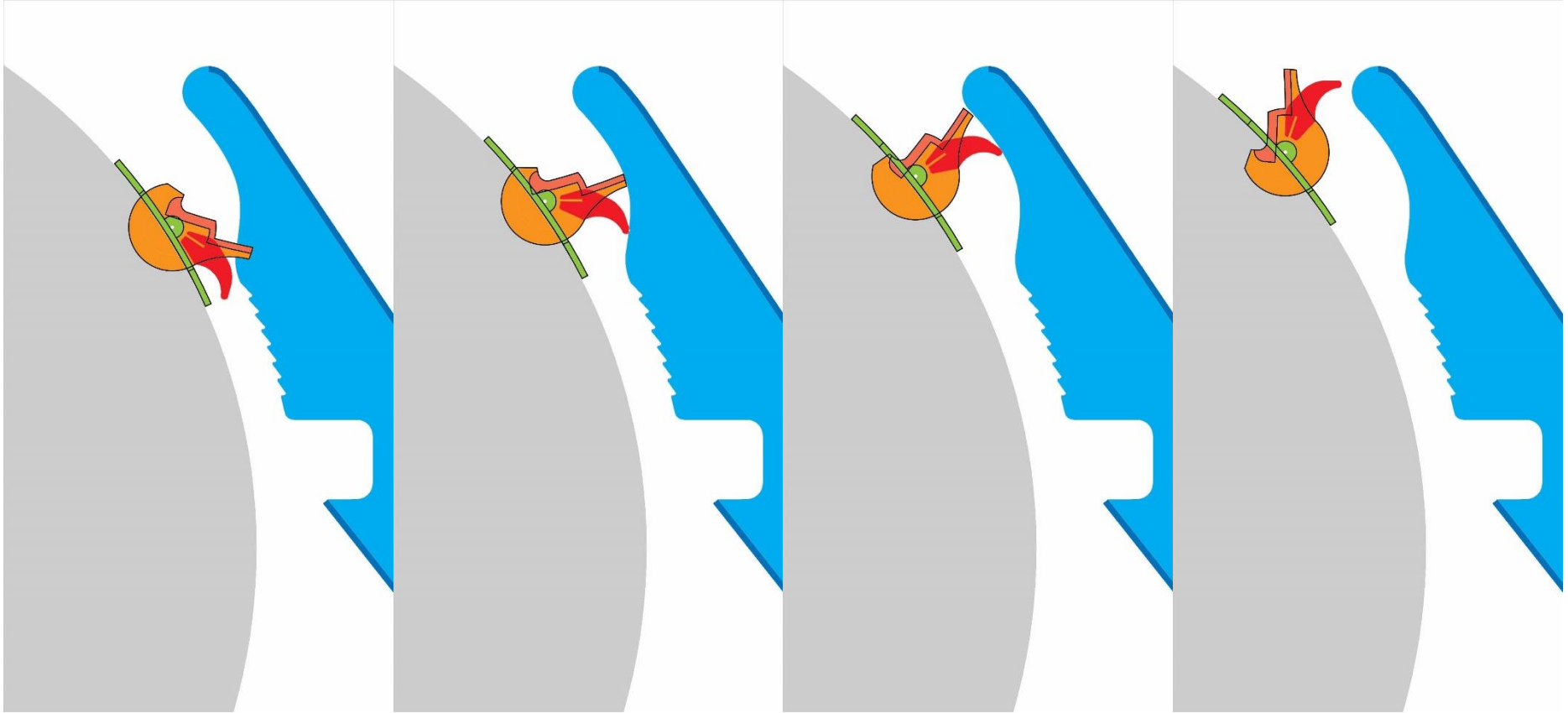
Frame 9



Frame 10



Frame by frame analysis of cap movement
Resolution: 1 degree



Disengagement of the cap with the cam to reduce snap back

Resolution: 1 degree

Observations

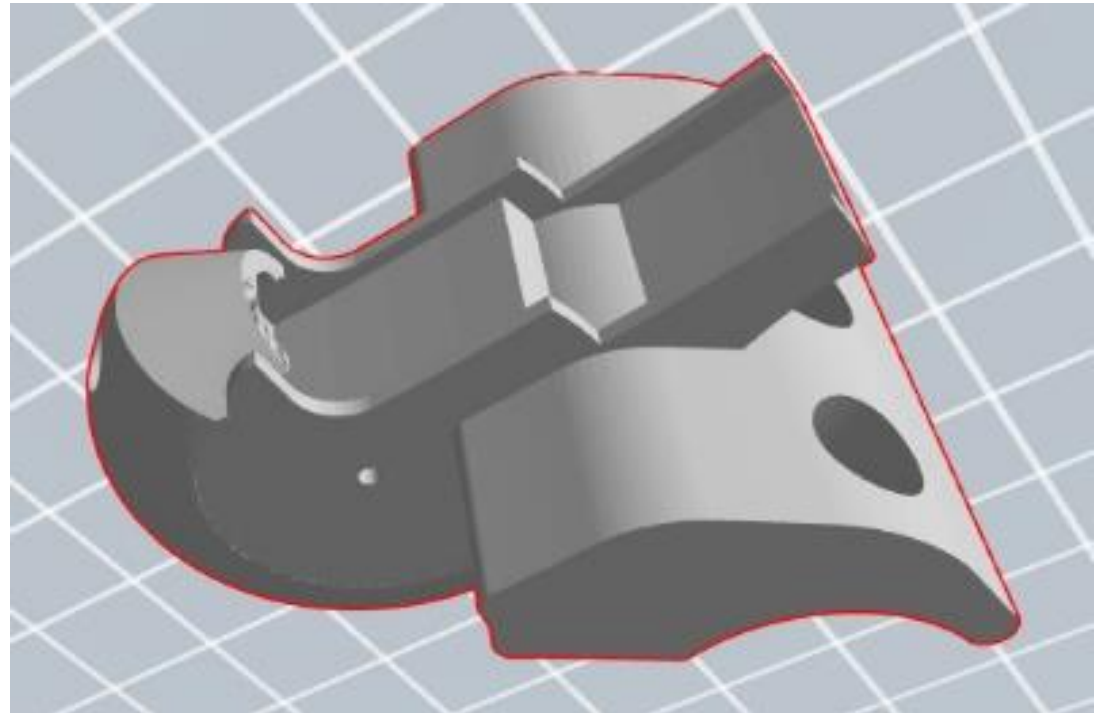
- Seed capturing is good
- Seed dropping is good
- Snap back is reduced
- Bigger size helps
- Weak joint between cap and lever

6.8 Prototype 5

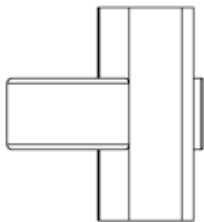
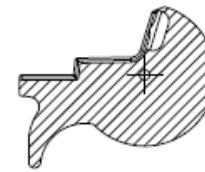
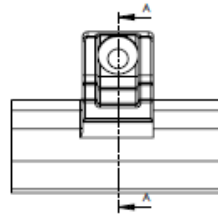
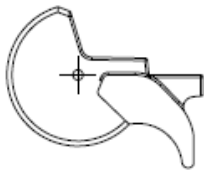
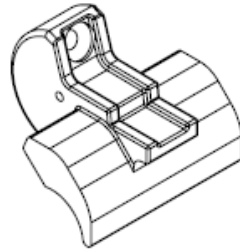
Prototype 5 was chosen as the final design.

The design consisted of simple extruded shapes intersecting at right angles.

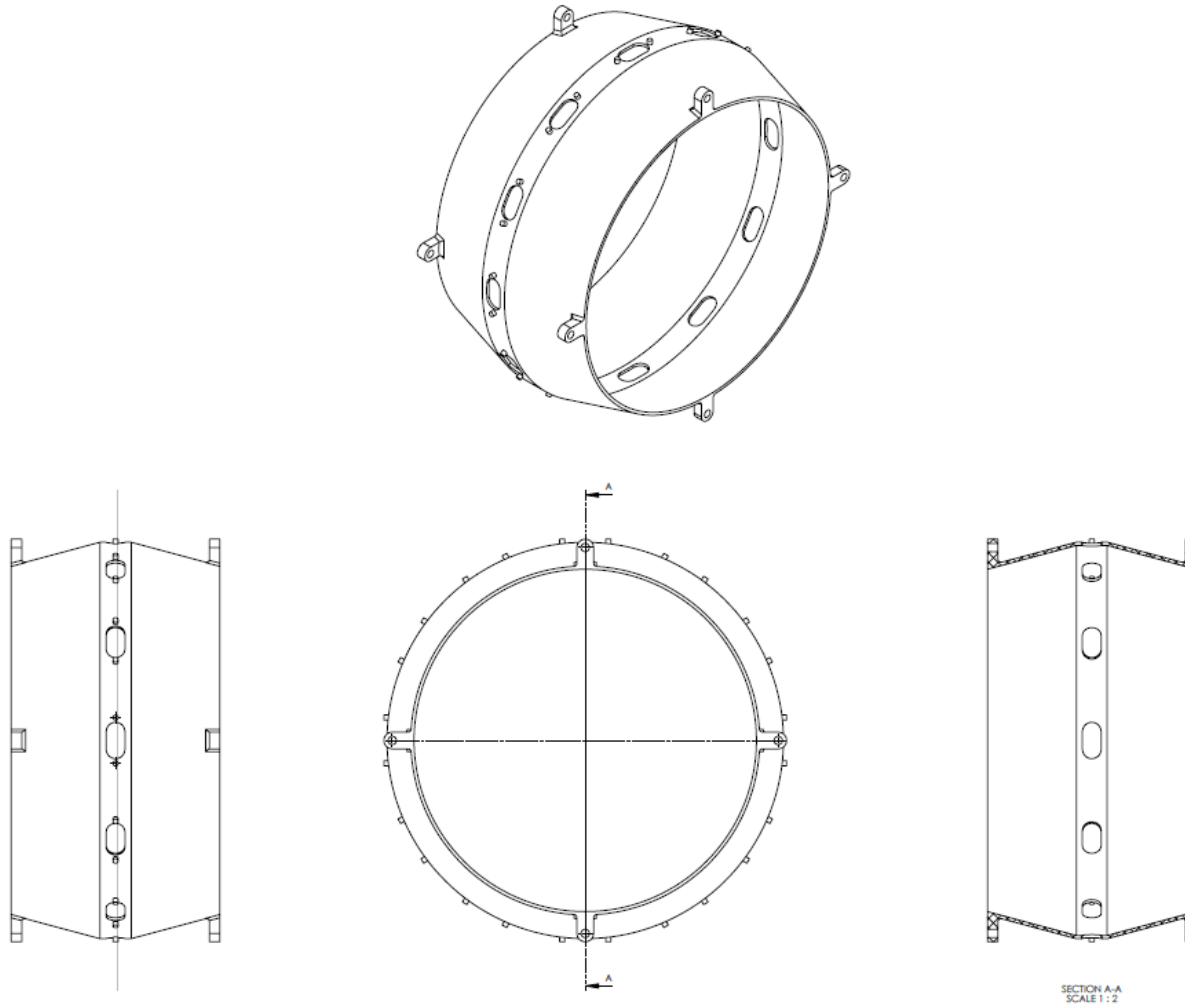
The design would also make the dye making process easy.



6.9 CAD drawings



6.10 CAD drawings of drum



7.0 Further development of the project

- Fix all the individual caps onto one belt so the farmer can easily change all the caps on the drum at one go.
- Adding a screw cap to the drum to provide ease of filling and emptying of seeds.
- Provide a panel to the truck driver which indicates with a red light when seeds are not falling from a drum

8.0 Letter of completion

 **PG AGRI INFRA PRIVATE LIMITED**

To,
Head of Department, IDC
IIT- Bombay, Powai.

Dear Sir/ Madam

This is to certify that **Maddu Shravan Murali** (Roll no.176130004) of **IDC, IIT Bombay**, successfully completed 4 weeks of internship i.e May 16th to June 16th. in the project of developing a "smart multi grain seed planter farm equipment". During this period he was able to deliver all the agreed upon requirements.

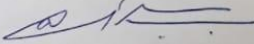
During the course of his internship at PG AGRI INFRA PVT LTD Maddu Shravan Murali showed exceptional product design skills and was instrumental in developing a critical piece of technology to enable successful seed metering design. He was also able to quickly understand and practice Human Centered Design principles and develop ergonomic solutions.

Below is an assessment of his work

Design - Ergonomic product design : A+
Rapid Prototyping - 3D print and handmade prototypes : A+
Report submission : A

Overall PG AGRI INFRA PVT is greatly obliged towards the efforts of Maddu Shravan Murali and his name will be considered to be included as one of the inventors in the IP owned by PG AGRI

Your Sincerely
Anujay Rao


Director and Head of Design ,
PG AGRI INFRA PVT LTD

Head Office : 1-1-10/411, JAWAHAR NAGAR, HYDERABAD - 500 020
Branch Office : H.No. 39, Pooja Nilaya, Sainik Colony, Near Irrigation Quarters, Joshi Farm, PB Road, DHARAD - 580 006, Karnataka