



Design intervention in Ambadi Calyx removal

Project 3- final presentation

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Guide: Prof R. Sandesh

All images by author unless specified otherwise

Ambadi

Popularly known as Roselle around the world

Grows majorly in the tropical belt, heavy presence in China, Malaysia, India and Africa

In India, grows in Maharashtra (mostly Vidharbha region), Andhra Pradesh, North East and some parts of the Ganges Delta

Cultivation cycle parallel to that of cotton, encouraged as an intercrop due to its organic insecticidal nature

Traditionally rooted in Indian culture- Gongura sabzi presented to Mahalaxmi devi, Ambadi chutney is a popular *daadi ki recipe* in Vidharbha region- but the crop is slowly losing its niche due to lack of commercial capabilities seen by today's farmers



Uses

Fresh Calyces-

Jam, Sharbet, Spread spread, Chutney, Jelly

Dried calyces-

Tea, health drink powder

Leaves-

Sabzi

Seed-

Oil extraction, dietary protein source

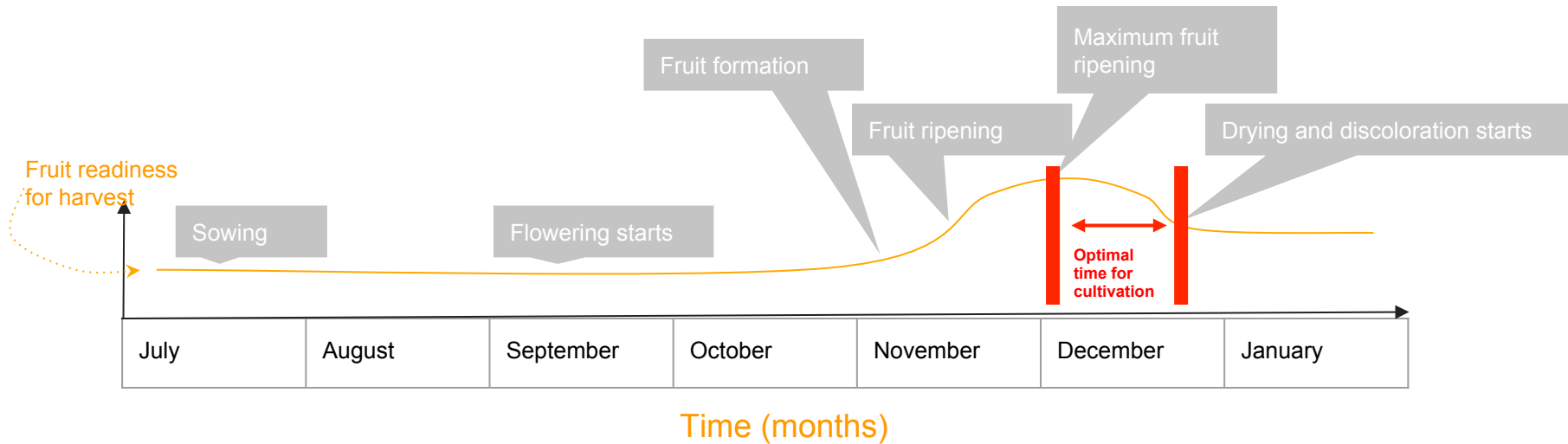
Stem-

Bast fibre



Harvesting cycle

Ambadi is a Kharif crop and allows a small time window of 15-20 days for cultivation (crop cutting)
It starts drying soon after and separation of calyces need to happen within 2-4 days of cultivation



Design problem at hand

Calyx separation process is done manually currently, due to the several factors:

- Organic shape and dimension
- Removal process depends heavily on the orientation- unlike cherry or olive depitting
- Fruit dries within 3-4 days of harvest and separation can only happen within this time frame
- High climate dependence of crop allows for a small annual window of 2 weeks for cultivation

Manual process lacks standardisation and hence productivity cannot be estimated well



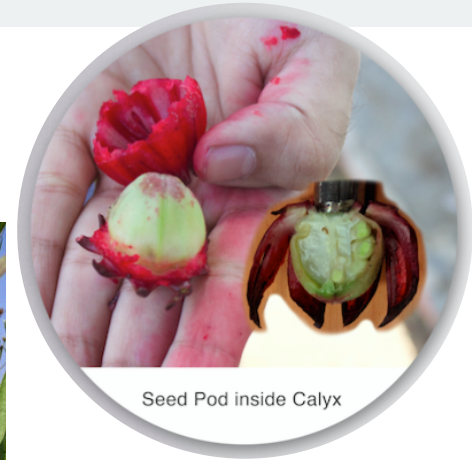
More about the Flower

Roselle is an erect, bushy herbaceous subshrub that tops out at anywhere from four to seven feet tall and almost as wide

Stems are typically round and smooth.

When flowers first open, they are light yellow with a rose or maroon eye. As they mature during their one-day life span, they gradually darken to a dusty rose colour.

At the base of each flower is a fleshy, bright red structure called a calyx (sepal). It is this part that is harvested.



Seed Pod inside Calyx

Fruit dimensions

3.5-5.5cms in length

2.8-3.7cm in width

Seed pod:

1.8-2.5cm diameter

Human factors

Heavy tangerine nature of the fruit makes it very acidic along with leaving a strong residual color on the hands

Large scale manual separation done for production purposes tends to discolour skin and ruptures the epidermis

Since the separation activity only lasts a few days every year, no formal design interventions have been made yet, In about 10 days, the whole produce is cut, separated and put out for drying

Area under cultivation depends heavily upon availability of large scale labor

Hence a design intervention in the form of a tool or machine is desired in order to enhance the current productivity as well as optimize it for scaling according to available



Field visit

25th-27th October (Non flowering season)
Nagpur and Wardha

Nagpur

Contact:
**Mr. Sanjay
Deshpande**
Agro-Entrepreneur
Has cultivated
Australian variety
Roselle this season



Roselle ready for harvest



Mr. Deshpande giving feedback on ideation mockups

Separation video
[Link:](#)



Salaried farmer in the background



Separated seeds from a freshly opened pod

Nagpur



Steel rod tool used to plunge out the seed



Cutting tool for cutting from stem



Idea 1 and 2 testing



Dried seeds from last year's produce for sowing



An attempt to quickly test my concept 3 with available resources

Wardha

Contact:
**Dr. Soham
Pandya**
Director, Centre for
Science in Villages

CSV works
towards livelihood
generation for
villagers while
supporting small
entrepreneurs with
Ambadi





Farm under cultivation this year- 2 Acres



Some shoots still haven't crossed
flower shredding phase

Key observations about Ambadi-

- Starts drying immediately as you cut it from shoot
- Within 3-4 days becomes dry and calyces stick harder to the seed pod- making it futile for separation
- If kept too long after the maximum ripening, it starts to lose its color and later the whole plant starts drying as it gets colder
- In a day, about 8-10Kgs Fresh Ambadi fruit can be separated by hand by one person. This is the evening occupation for many families there

Economics at Play

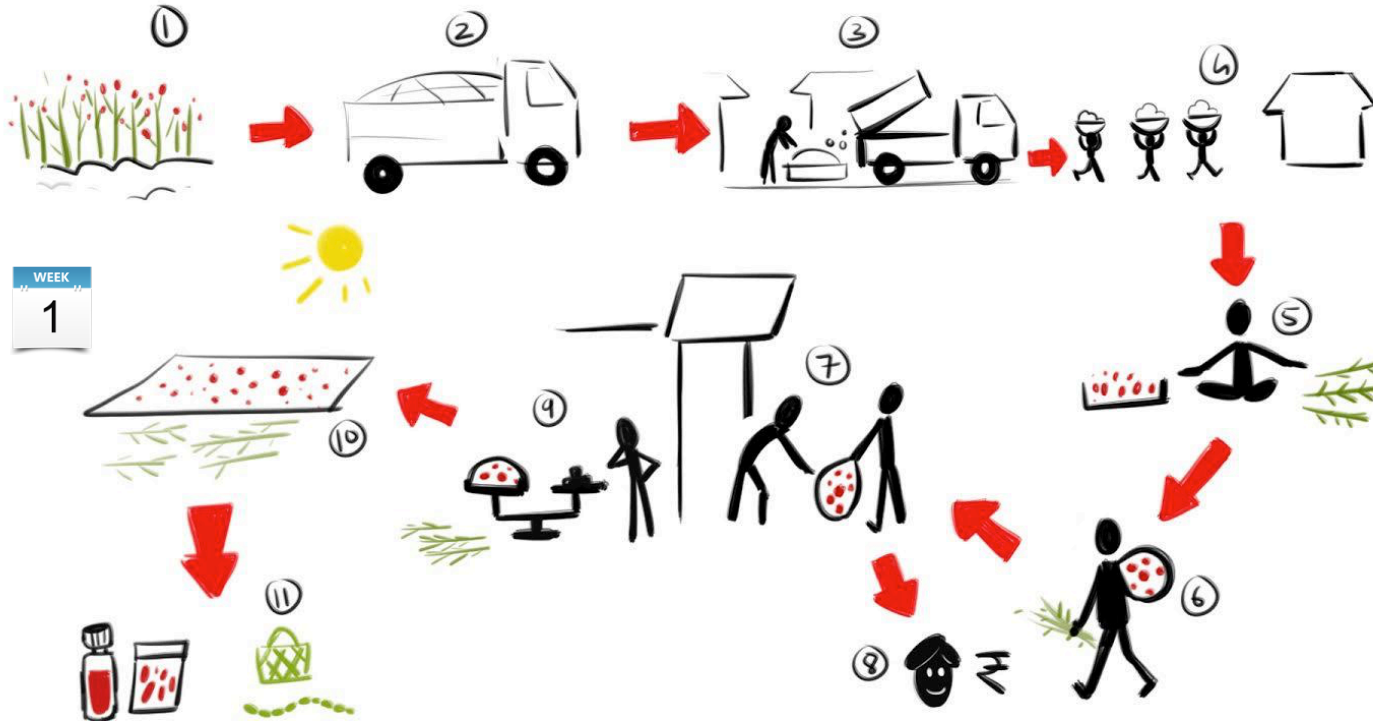
[illegible]

On average one person currently separates 5-6Kgs of fresh fruit daily based on availability of stock to separate

Females of the house are seen to be involved in the account keeping. While their In-laws and kids also do the separation activity in case need be

CSV pays 15Rs/Kg of separated calyces and keeps the shoots with seed pods with themselves

Farm activity



1. Cultivation and harvest at farm
2. Removal of Shoot upon preparation and transport to village
3. Villagers receive shoots of Ambadi from truck
4. Shoots divided amongst villagers and taken home for separation
5. Manual separation of Ambadi calyces while seed pods kept o shoot
6. Separated calyces taken to collection centre by villager
7. Calyces received
8. Villager paid
9. Calyces weighed
10. Put for drying for 7-10days
11. Dried calyces packedfor selling

System models observations from visit

Farmer- Entrepreneur

- Cotton farmers in catchment encouraged and trained to intercrop Ambadi with cotton
- Entrepreneur also cultivates in own facility
- Seeds and Pipe tool (for separation) provided by entrepreneur
- Farmer cultivates, cuts, separates and dries ambadi calyces
- Entrepreneur buys back dried Calyces as per weight from farmers, processes into tea
- Processing and blending done by entrepreneur who then sells the tea under his own brand

Vertically integrated QC ensured by

Institute- livelihood generation

- Institute owns the farmland and cultivates Ambadi
- Cotton picking labourers from nearby village engaged in cutting and separation
- Institute buys back freshly separated Calyces (not dried) from labourers on weight basis
- Dried Ambadi calyces sold as white labelled to nearby entrepreneurs on weight basis
- Entrepreneurs mostly engaged in Sharbet making activity
- Institute also makes Jam, bread spread, achaar on their own and sells on their own

QC of dried calyces ensured by Institute, final product QC ensured by enterprise

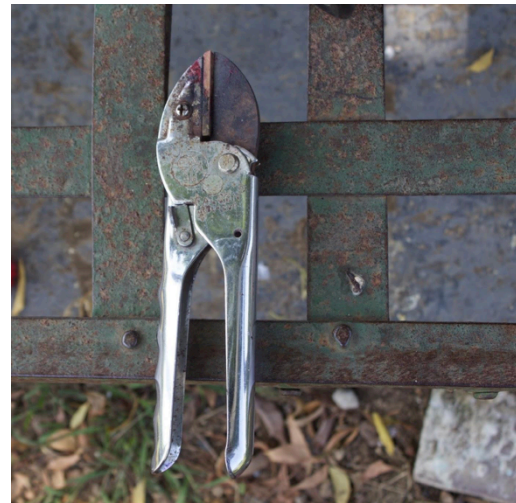
System model and economics observed

- Both find payment for labour on weight basis more suitable as opposed to number of fruit basis or time
- Approx 10Kg fresh Ambadi fruit can be processed by a labour in a working day
 - Entrepreneur currently gets full time labour @Rs150/day who separates 20Kg fresh Ambadi full fruit and pays additional Rs160/day for about 20Kg of cut fruits
 - When he buys dried Ambadi calyces from farmers, he pays them Rs 250/Kg
 - Institute gets part-time labourer families engaged in cotton picking and calculates productivity on per Kg of freshly separated calyces @Rs 30/Kg. Cost for cutting is borne by the village labourer (if cultivation is large) or institute (if cultivation is small)
- 1Kg Ambadi fruit roughly has 450-500grams fresh calyces which when dried result in about 50grams of dried calyces- which has a retail value of about Rs 350/Kg
- Starting point of enterprise is dried calyces. Institute can afford a slow drying period, since a lot of land is available, while entrepreneur needs to invest in land for sun drying and wants to look for quick drying options



Existing crop tools

How its cut



Agricultural
scissor/Florist
scissor

Nagpur
-at Mr. Deshpande's farm

Labourers cutting ambadi shoot from ground

Drying and material handling- at CSV



Use of open air drying at Karla centre

Since a large basket is used for weighing dried calyces, gross weights are used over a typical vegetable weighing scale



Issues in current handling



Scab formation on Thumb region

Ladies have complained of burning sensation after long hours of separation activity



Posture- Existing way of separation



Jyoti Balujibagade (Age 35) at village Karla, Wardha separating Ambadi Calyces from shoot in her usual posture



Suresh (Age 59) at Nivedita Nilayam, Wardha separating Ambadi Calyces from shoot in his usual posture

Complete shoot is kept on the lap and each fruit is taken in hand one by one for separation

Seed pods are left on the stem for drying later

A trough is used to collect separated calyces..later bound in a cloth or kept in a basket for bringing to CSV for selling

Initial Design brief



To design a machine for enhancing the production performance of Ambadi calyx removal process.

The machine as opposed to a hand tool, would cut multiple ambadi fruits at once.

The device should ensure effective separation of Calyces and seed pods in a convenient fashion.

Full recovery of calyces required as opposed to shredding. The machines Should require less skill to operate -and be suitable to work with self help group models.

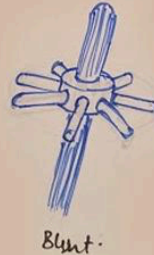
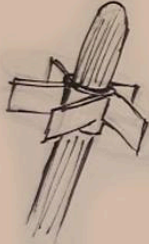
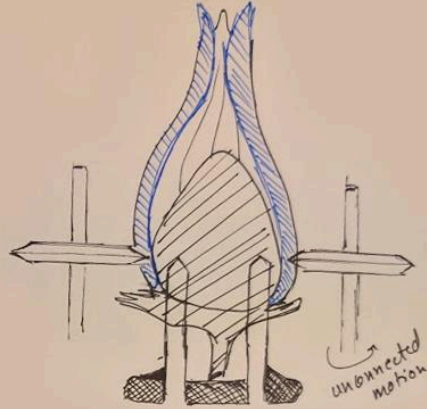
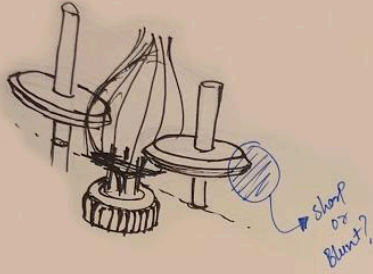
Manual mechanical interventions are preferred over complete/semi automation using electric motors.

The machine should be manufacturable at the district level

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Ideations

Cutting tool options



Idea 1- scoring and peeling

Idea is to score the ambadi calyces from the periphery and increase the depth of cut until it separates itself from the base (which includes the seed pod)

Idea 1- Mockups



Peeling concept



Option a) Cutting blade rotates,
fruit held by hand



Refined concept- standalone

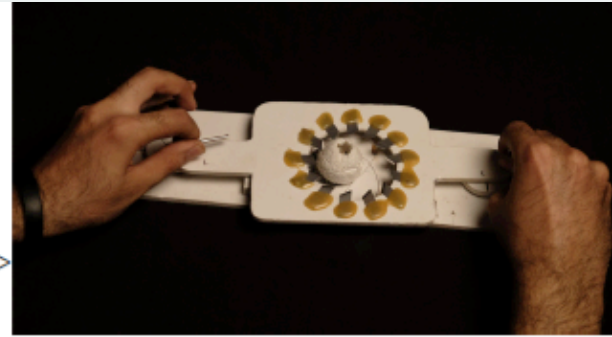
Option b) mount rotates, cutting
blade static

Mockup

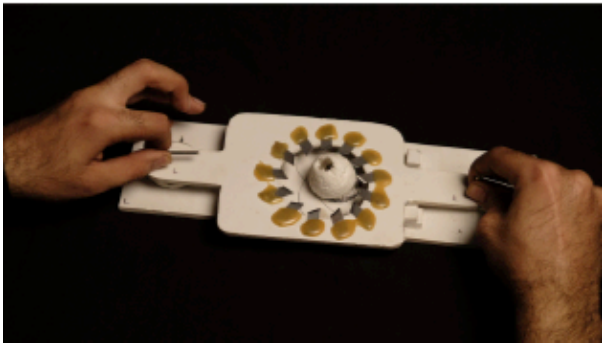
Refined concept
for peeling



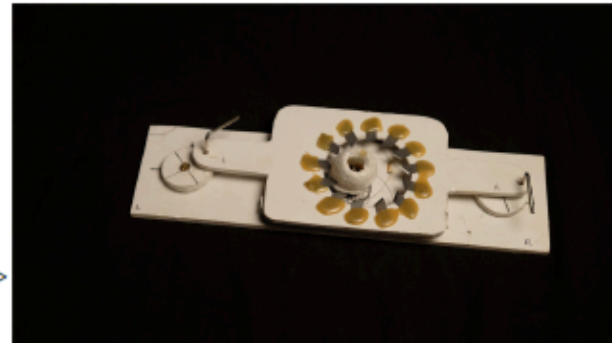
< Mounting
Ambadi on a static
centre



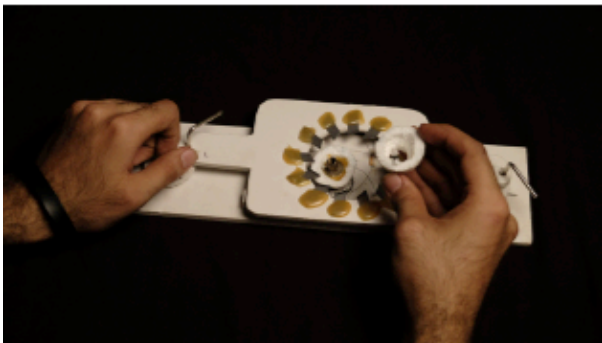
Rotating blade >



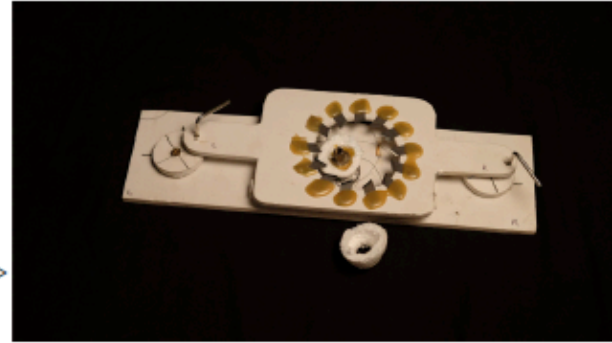
< Further blade
rotation (complete
a 360 degree)



calyx (top) gets >
separated from
seed pod



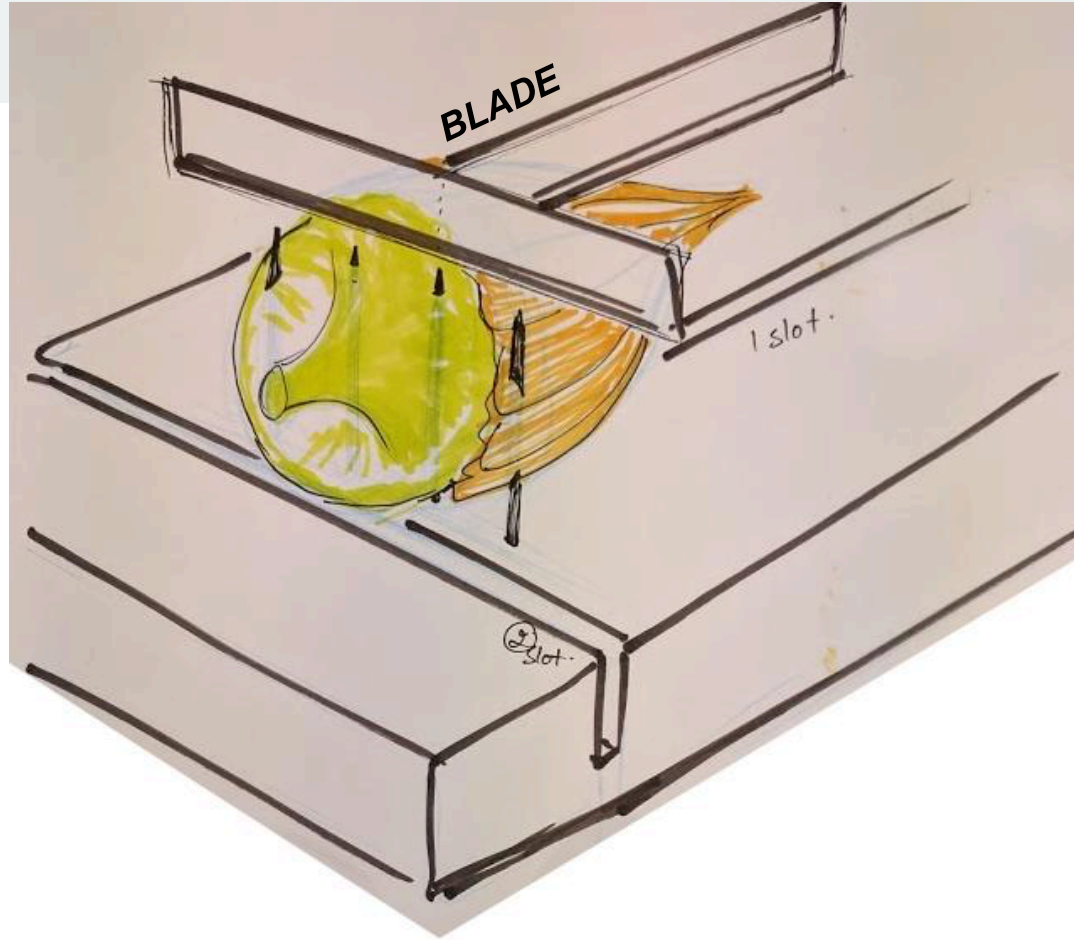
< Separated calyx



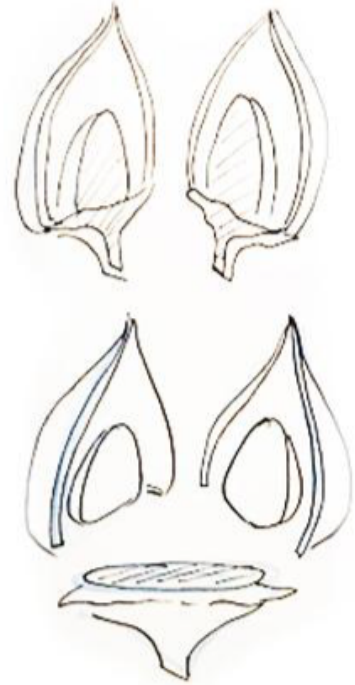
Seed pod remains >
on central mount

Idea 2- slice and separate

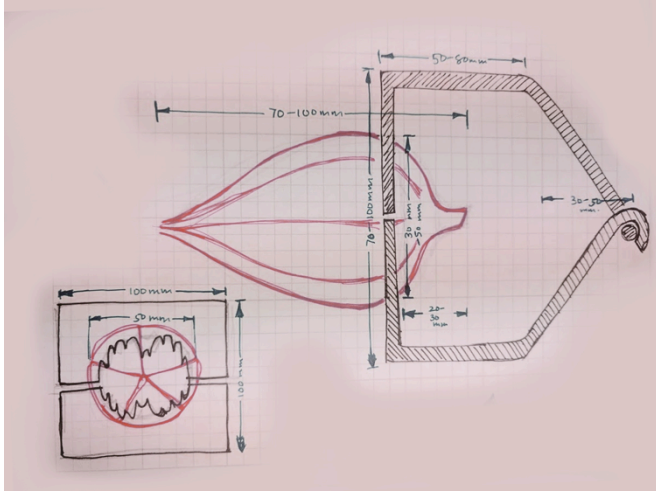
The core idea being-
slice the fruit through
the calyx and seed pod
and separate later



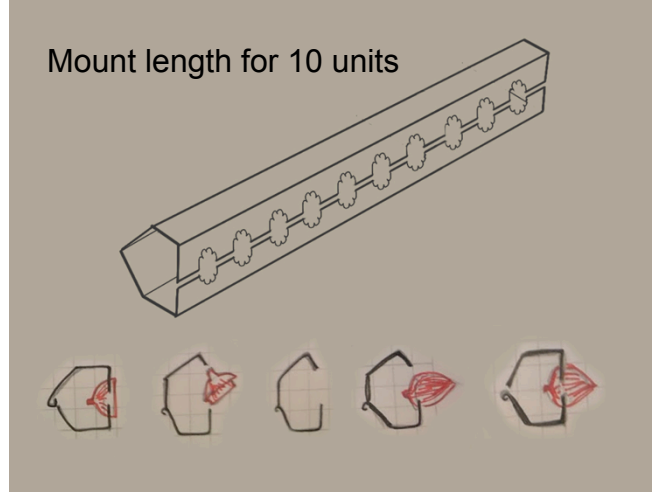
Cutting concept



Blade fixture details and length for cutting 10 units



Cross section of ambadi mounting



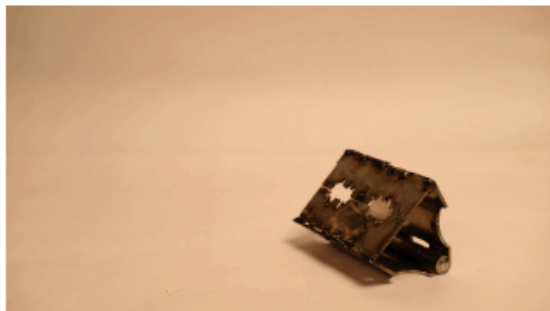
Procedure of dismounting seed pods and mounting fresh ambadis



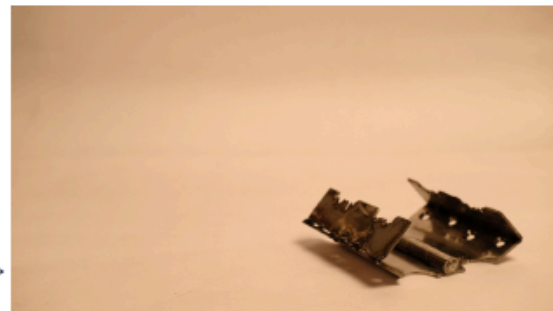
Mockup

Mockup detail

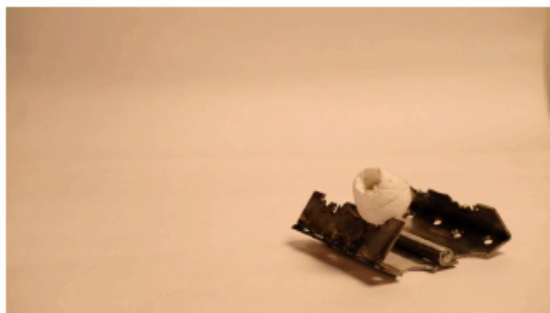
Two unit mockup made for demonstration



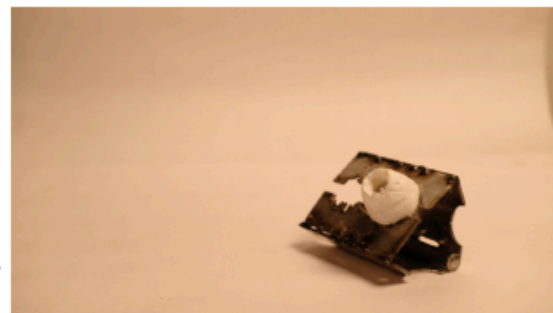
< Unopened jig



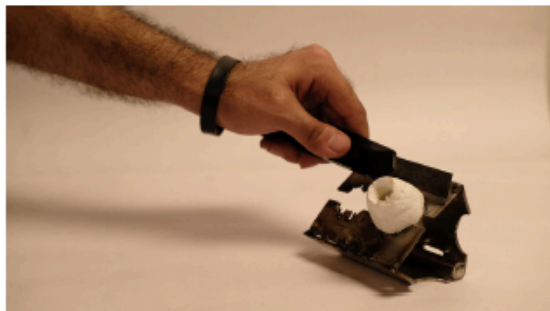
open jig >



< Ambadi placed



Jig closed >



< Blade cuts through Ambadi



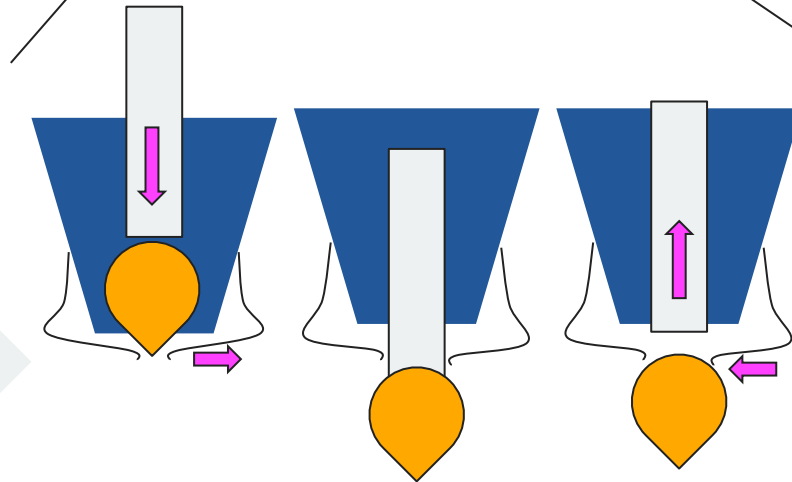
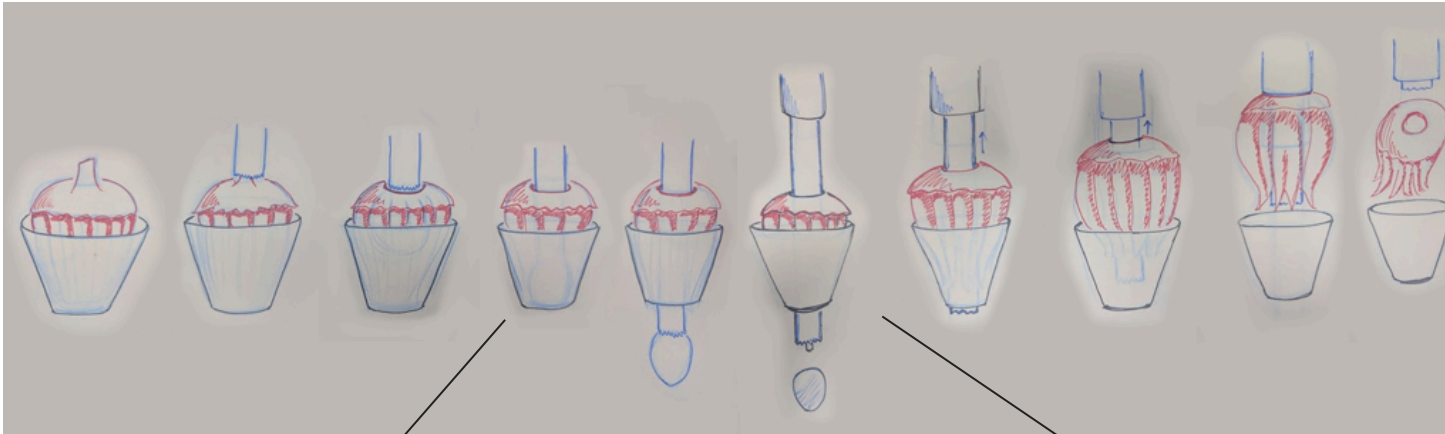
Seed pod remains on mount, Calyces separated >

Idea 3- Pipe and bore

Taking inspiration from the umbrella pipe tool used in malaysia, this concept attempts to replicate the whole human process mechanically

[Link:](#)

The pipe is designed to cut through the calyx and push the seed pod through its centre



Idea for pod
removal in single
plunge

Pipe and bore Mockups



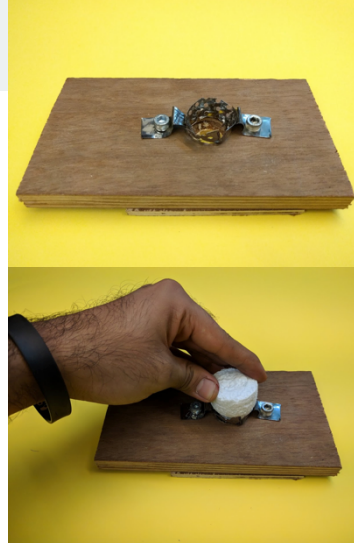
stand



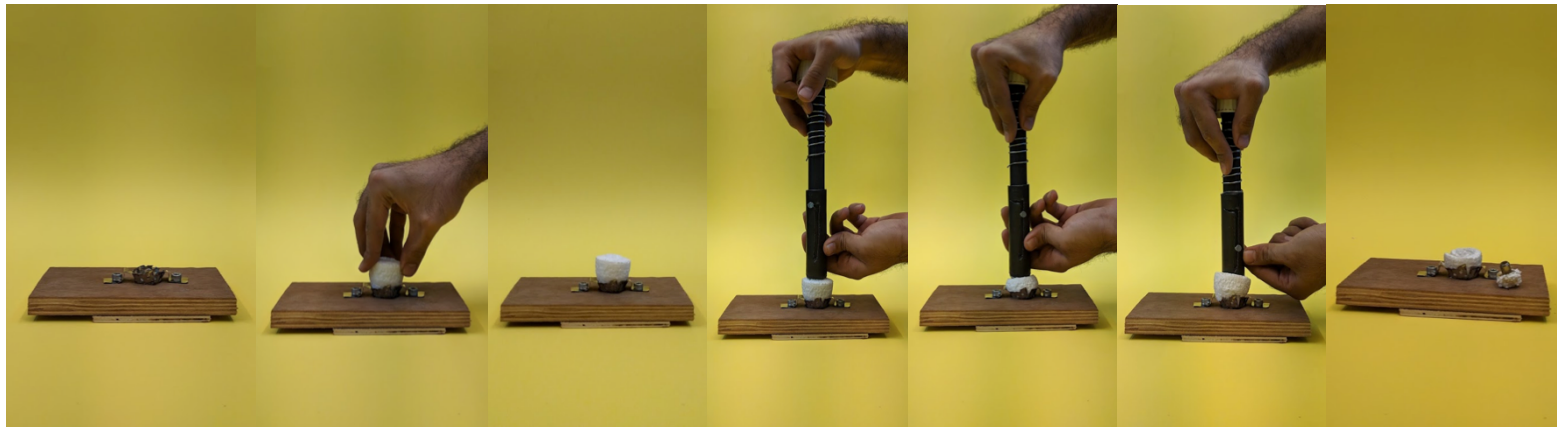
Rod



Cutting edge



Base made for mounting
Ambadi fruit



Cutting action



Dummy fruit with a hard
seed pod

Concept rigs for field testing



Vertical plunge concept



*Handle concept with variable height
enabled by slotted angles*

Field visit-2

10th-12th December (Cultivation season)

Wardha and village Karla

Points of observations and evaluations



- Observe current method of separation
 - Sitting posture
 - Stem Handling
 - Post separation material handling
 - Time taken
 - Energy expenditure/Fatigue--via Heart rate
- Test rigs for
 - Ease of use
 - Possible posture
 - Time
- Details on economic productivity for the season for Wardha-CSV

Visit summary

Site-Nivedita Nilayam (associates of CSV, Wardha)

Ambadi crop land size: ½ acre (2 rows)

Crop intent: Household consumption by Nivedita Nilayam members and students in the summer months for making *sharbat*

Subject: Domestic help, kitchen assistance- Mr. Suresh

Age: 59yrs

Mandays for Ambadi separation:

~2kg fresh Ambadi separated in day and same in evening in sittings of 2 hours each

Uprooting and transportation:

- Ambadis from lower portion of the shoot mature faster, hence are cut first, seed pods and separated calyces kept in different containers for drying
- In the later stages of the season, Whole shoots cut from bottom and seed pods post separation stay on the shoots

Storage- Intermediary and final:

Fruits cut as per separation capability of the day. On peak days, other members of NN also do the separation activity



Visit summary

Site-Karla village (CSV centre for Ambadi)

Ambadi crop land size: 2 acres for 2017

Crop intent: Drying and selling Ambadi Calyces or processing into jam/achaar. Income generation for nearby households via manual separation also happens

Subject: Homemaker- Jyoti Balujibagade

Age: 35yrs

Mandays for Ambadi separation:

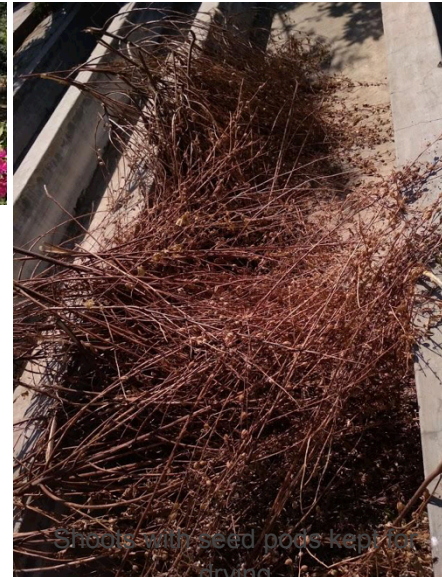
This season- 21Kg separated in 3 days amongst herself and daughter

Uprooting and transportation:

- Cut shoots enter CSV Karla in a contract carriage
- Villagers come and receive full shoots and take the home (shoots counted in *pendeys* or *jhaadi*)
- Separated Calyces(wrapped in cloth) and shoots with seed pods attached brought back to centre
- Calyces are weighed and money for the villager is credited in the ledger

Storage- Intermediary and final:

Open drying of Separated Calyces done at centre premises. Final packets of dried calyces sold directly to buyers who pick it from CSV centre



Concept feedback

Plunge without handle



Requires a lot of force and position of handle not found to be convenient

Plunge with handle lever



Lever ensures reduction in plumbing force, base jig for Ambadi holder not found to be suitable for the current size.

Retrieving the Calyces is still difficult

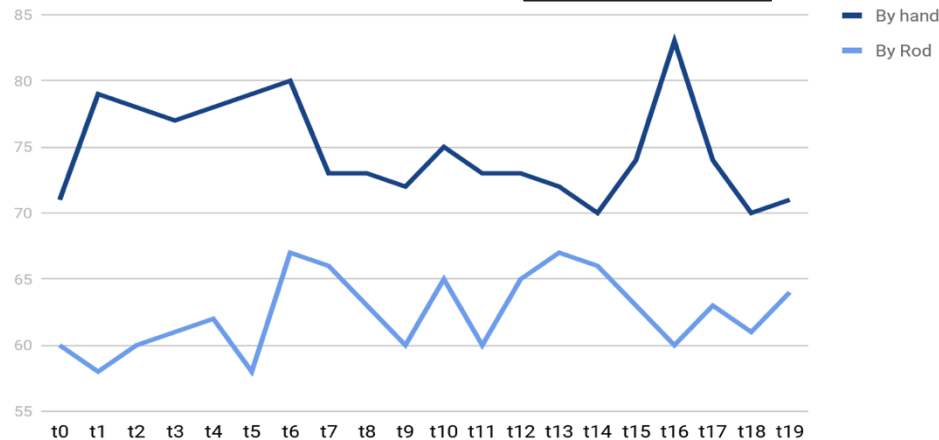
Postures for workstation concept



Energy expenditure data (via Heart rate)

Heart rate (bpm)

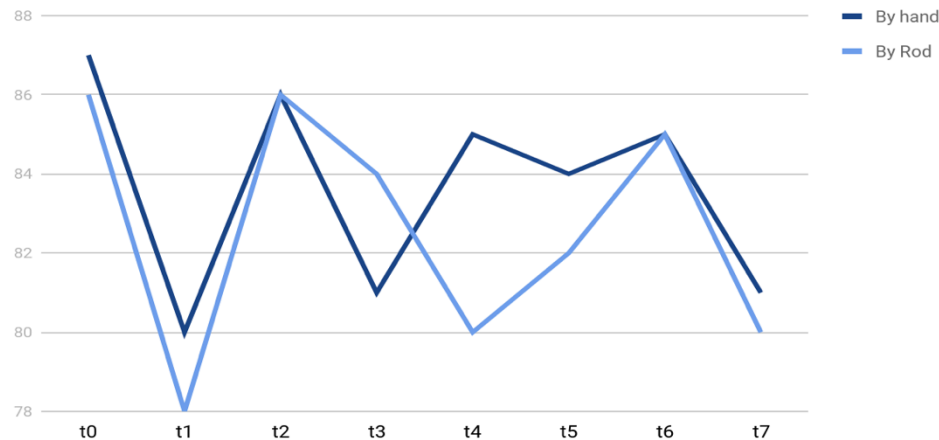
Mr Suresh



Considerable difference seen for Mr. Suresh but no such difference for Mrs Jyoti

Heart rate (bpm)

Mrs Jyoti



*Mr Suresh's data collection for 'use with rod' was done after he took a lunch break

Productivity

Mr Suresh (kitchen assistant):

- Separating 120 Ambadis by hand, averaged 8.70 seconds per fruit
- Separating 120 Ambadis by the rod, averaged 8.10 seconds per fruit

Difference not significantly different at 95% confidence level

Mrs Jyoti (Villager):

- Separating 50 Ambadis by hand, averaged 8.30 seconds per fruit
- Separating 50 Ambadis by the rod, averaged 6.54 seconds per fruit

Difference not significantly different at 95% confidence level

Both users though observed the rod tool to be much easier to use as compared to separation by hand

Feedback on initial ideations from field visit



Idea 1

Scoring accepted, but removal of calyx needs to be worked on



Idea 2

Only calyx cone is recovered- has a lot of wastage of potent epicalyx



Idea 3

Most feasible, once mount is made compatible for full seed pod collection

Idea 1 and 3 taken forward for further development

Further development



*16mm dia, 4 teeth
blade edge*



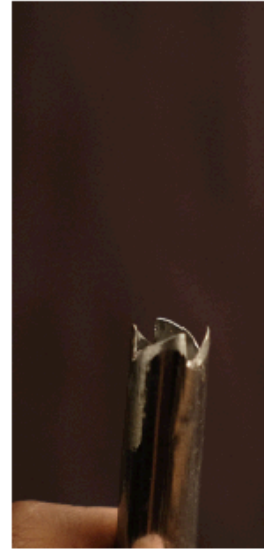
*16mm dia, 5 teetch
blade edge*



*16mm dia,
replaceable blade
edge*

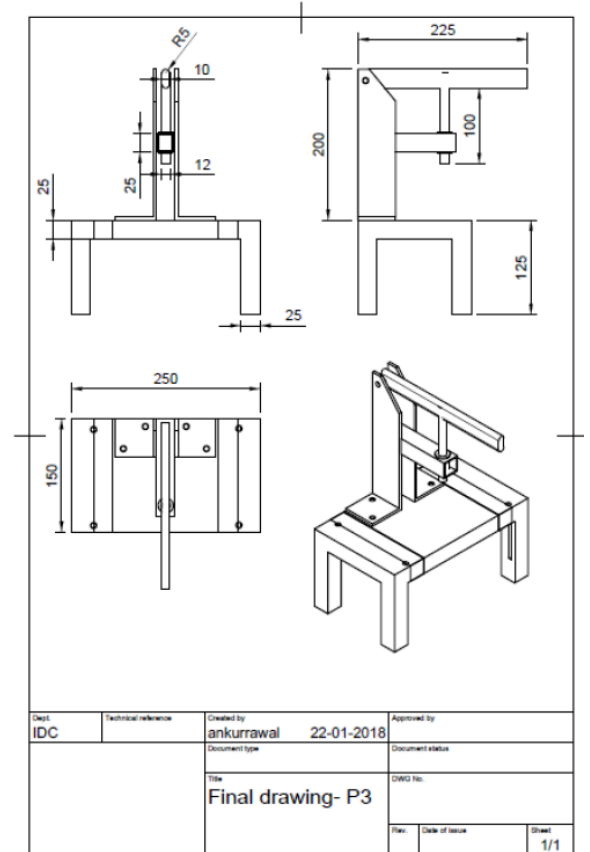


*Sharpened 19mm
hole saw attached as
replaceable blade*



*12mm sharpened
blade edge with 4
teeth*

Final design



Further testing

Container Orientation

Fresh Ambadi fruit container and calyx
container on either sides of machine
(slower, requires hand switching)



Ambadi fruit and Calyx
containers on same side of
machine
(faster, and does not require
hand switching)



Ergonomic Audit

- 1) Seated on a table/
workbench
- 2) On the floor



With stand on table
Table height- 81cm
Seat height- 72cm



Without stand on table
Table height- 81cm
Seat height- 44cm



Without stand on table
Table height- 81cm
Seat height- 72cm

Ergonomic Audit

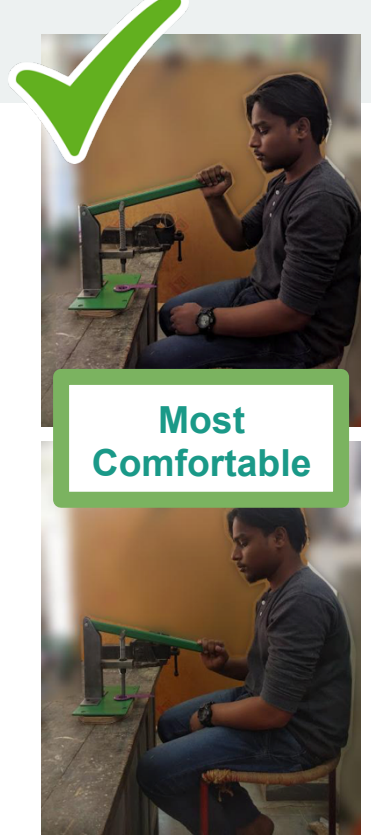
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With stand on table
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Without stand on table
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Seat height- 44cm



Without stand on table
Table height- 81cm
Seat height- 72cm

Ergonomic Audit

- 1) Seated on a table/
workbench
- 2) On the floor



With stand with stool
Seat height- 19 cm



With stand on floor



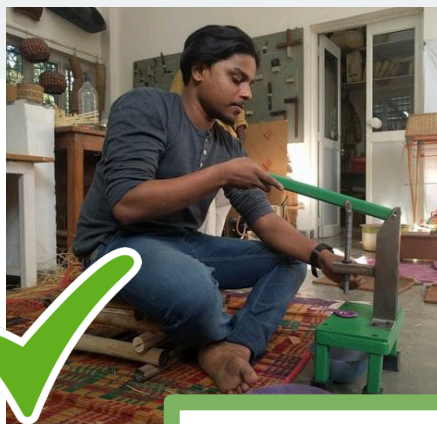
Without stand on stool
Seat height- 19cm

Ergonomic Audit

- 1) Seated on a table/
workbench
- 2) On the floor



**Most
Comfortable**



With stand with stool
Seat height- 19 cm



With stand on floor



Without stand on stool
Seat height- 19cm

Muscles at work



User felt slight strain in upper arm triceps upon extended use



In lower positions, wrist muscles also flexed beyond comfort



Thank you