

# DESIGN RESEARCH SEMINAR

## Participatory Research with Marginal Indian Farmers to Design Affordable Farm Tools and Equipment



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Mobility and vehicle design

( 2017 -2019 )

Guide: Prof. **Nishant Sharma**

## Declaration

I declare that this written report represents my own idea in my own words, and where others ideas or words have been included, I have mentioned the original source. I also declare that I have adhered to all principles of academic honesty and integrity and have not falsified, misinterpreted or fabricated any idea, data, facts or source in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the source from which proper permission has not been taken, or improperly cited.

Signature: 

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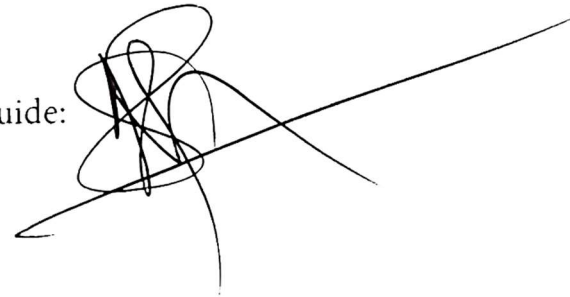
## Acknowledgement

This research would not have been possible without the help from a number of farmers, and I would like to express my sincere gratitude to them. I am deeply indebted to Prof. Nishant Sharma, who provided invaluable guidance and input during each and every stage of the research. His feedback was essential to ensure that the project was always moving in the correct direction. I am also thankful to my beloved friends who provided their own insights which helped me out with the project, not to mention their constant support. I would like to thank all marginal farmers who participated in the user research for this project. Finally I am thankful to IDC for providing all the necessary facilities and infrastructure for me to carry out the project.

# Approval Sheet

This Design Research Seminar project entitled “Participatory Research with Marginal Indian Farmers to Design Affordable Farm Tools and Equipment” by R.S.Mahesh is approved in partial fulfilment of the requirement for Master of Design degree in Mobility and Vehicle Design.

Project Guide:

A handwritten signature in black ink, consisting of several overlapping loops and a long horizontal stroke extending to the right.

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# 1. Abstract

Agriculture is one of the main sectors in Indian economy that accounts for 18% of India's GDP and provides employment to 50% of the country's workforce. India is the world's largest producer of pulses, rice, wheat, spices and spice products and holds second rank in total farm outputs. There are various types of farming methods in India depending on farm size, geographical conditions, climatic conditions, etc. In that respect, Indian agriculture is highly dependent on monsoon rain fall. Additionally, different seasonal crops are rotated to increase the fertility of soil.

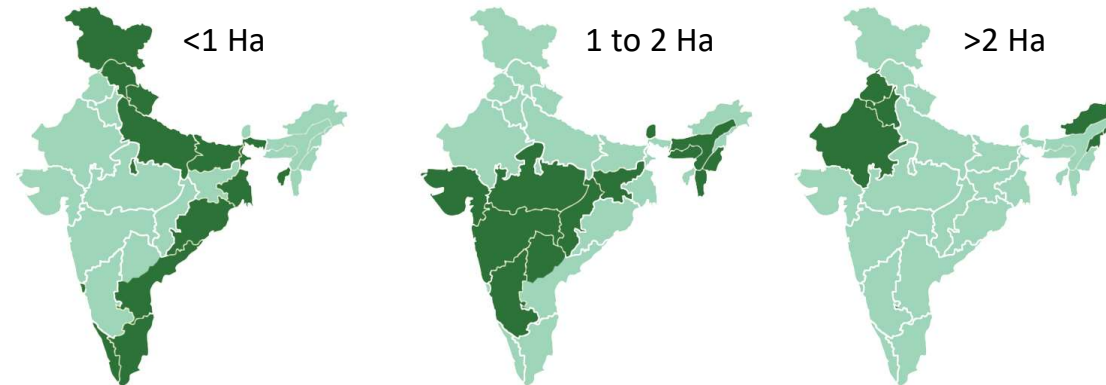
Farming tools and equipment are selected based on many factors like, power source, type of operations, type of crops, soil type, area size, affordability of farmers, etc. Tractors, power tillers and combines are mostly used by medium and large farmers that accounts for 40-45% of farm mechanisation. A large number of Indian farmers, however, are actually marginal and small farmers. They rely on manual or animal driven operations. In some cases, they hire farm equipment for some operations that proves expensive to them.

To design affordable farm tools and equipment for marginal farmers, Participatory Design Research through mediated participatory toolkit, was under taken to gain farmers deeper insights and aspirations. Through understanding of current farming practices in the field led to design of sensitising kit – a pictorial representation of farming method throughout the year and miniaturised farm participatory toolkit. This project attempts to present elicited deeper insights gained from emerging participatory research done with four groups of farmers (four farmers in each group); their farming experience and knowledge towards exploring new farm tools and equipment. This research in future would help focus design endeavours towards affordable, effective and context sensitive farming tools and equipment.

## 2. Agriculture and Farmers in India

Agriculture in India is mainly dependent on monsoon rainfall as 68% of farmers are marginal farmers who depends only on rain, river and canal irrigations. Agriculture method in India is different, as the average Indian farm size is just 1.15 ha when compare to developed countries like US, Europe whose average farm size are over 200 ha.

Average farm size across India (1.15 ha)

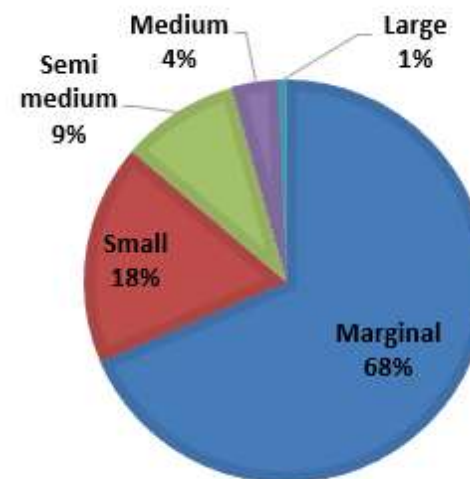


### 2.1 Types of farmers

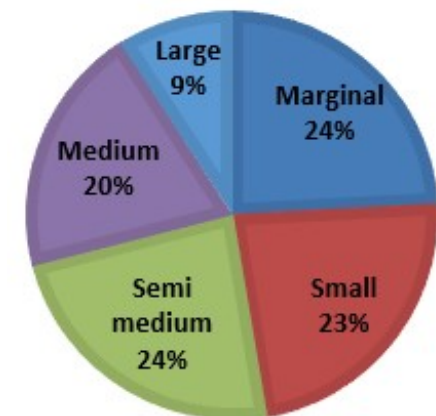
- Marginal farmer – (holds <1 ha) (avg – 0.4 ha)
- Small farmer – (holds 1 – 2 ha) (avg – 1.4ha)
- Semi medium farmer – (holds 2to 4ha) (avg -1.7ha)
- Medium farmer – (holds 4 to 10 ha) (avg -2.7ha)
- Large farmer – (holds >10 ha) (avg-17ha)

Most of the marginal farmers rely on manual and animal powered operations as they are not wealthy enough to afford tractors and other machines. Hence the Marginal farmers are targeted to conduct participatory research to design affordable farm tools and equipment

Farmers in India



Farm output share



## 2.2 Types of Farming in India

### Shifting Farming

- Forest 'slash and burn' agriculture.
- Ashes mixed in soil / start cropping
- If loses its fertility, farmer shift place
- Quick regeneration of vegetation.
- Heavy rainfall region
- Widely practiced in northeast India



### Subsistence Farming

- Just to meet the needs of the family.
- Simple farming tools are used.
- Whole family work in the farm.
- Mostly marginal farmers practise



### Commercial Farming

- Industrial farming
- Crops grown for commercial purpose
- High yield seeds, fertilizers, pesticides, tractors/combines are used.



### Plantation Agriculture

- "Monoculture" single crop grown
- type of commercial farming
- tea, coffee, sugarcane, cashew, rubber, banana or cotton are grown.
- Large labour and capital are required.



There are various types of farming based on farmer's capacity, monsoon, soil fertility, Geographical factors and Commercial purposes.

### Terrace cultivation

- slopes are cut to form terraces and used for agriculture.
- Use of machines is not possible



### Mixed crop farming

- 2 or 3 crops together on the same land
- Grown in scattered manner.
- To minimize the risk of crop failure.
- No farm machines can be used
- Harvesting done manually.



### Inter crop Farming

- 2 or 3 crops together on the same land
- Crops grown in proximity.
- To increase the yield from unit area.
- Usage of farm machine is possible



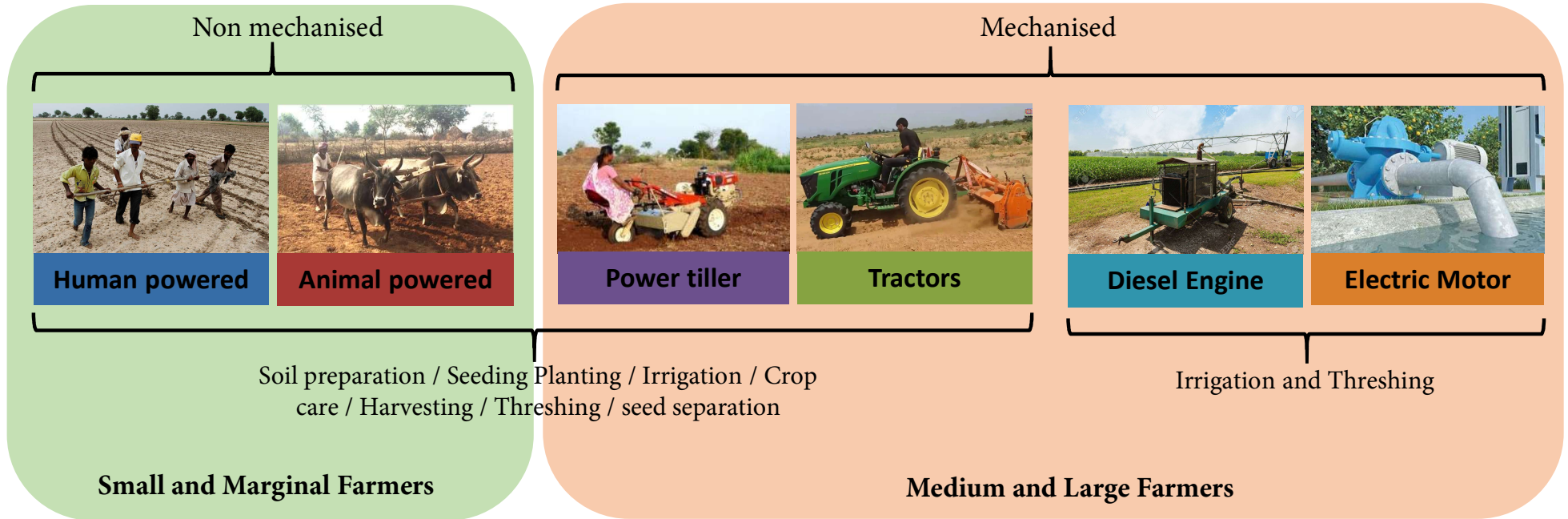
### Crop rotation farming

- Crops rotated to improve soil fertility



Small and Marginal Farmers follows - Subsistence farming, shifting farming, terrace cultivation, mixed crop farming, crop rotation farming.

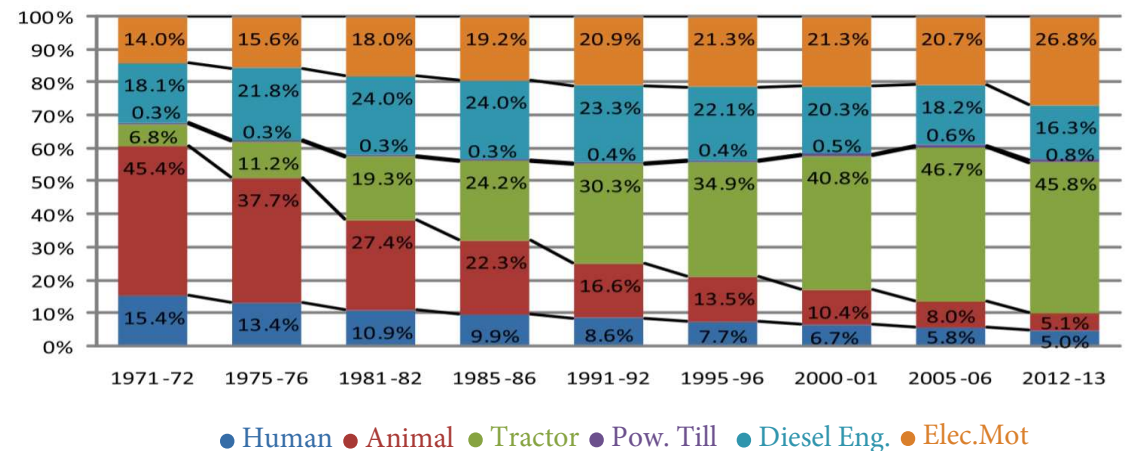
## 2.3 Farm Mechanisation in India



After Green revolution in India, agriculture was converted into an industrial system by adoption of modern methods and technology such as the use of high yielding variety seeds, tractors, irrigation facilities, pesticides, and fertilizers which increases the yield. Mechanisation started growing and reached 40 to 45%.

### Operations wise mechanisation:

- Soil bed preparation – 42% mechanised
- Seeding and planting, - 29% mechanised
- Plant protection – 34% mechanised
- Irrigation – 37% mechanised
- Harvesting – 65% mechanised



Farm mechanisation trend

## 2.4 Monsoon and Seasonal crops in India

<p><b>KHARIF</b></p> <p>Wet monsoon</p> <ul style="list-style-type: none"> <li>• Wind from south west</li> <li>• June to Sept</li> </ul>	 Paddy	 Sorgham	 Ragi	 Cardamon	 Turmeric	 Red Chilli	 Black Pepper	 Castor
<p><b>ZAID</b></p> <p>transition</p> <p>Apr May</p>	 Pumpkin	 Cucumber	 Watermelon	 Muskmelon				
<p><b>RABI</b></p> <p>Dry monsoon</p> <ul style="list-style-type: none"> <li>• Wind from north east</li> <li>• Oct to march</li> </ul>	 Wheat	 Coriander	 Sunflower	 Lentils	 Mustard	 Sesame	 Green Pea	 Potato
<p><b>ALL TIME</b></p>	 Cauliflower	 Nutmeg	 Garlic	 Fennel	 Lemon	 Brinjal	 Chana	 Banana

**Kharif crops** are the crops which are grown in wet monsoon season. During this season lot of rainfall happens because of wind from southwest. Most of the kharif crops are sown in June –July when first rain begin. Harvested in September – October. These crops needs lots of water and hot weather to grow.

**Zaid crops** are the crops which are grown between major season Kharif and Rabi. During march to June. These are early maturing crops.

**Rabi crops** are the crops grown in dry monsoon season. Very less rainfall happens because of wind from north east. Most of the Rabi crops are grown in October – November and harvested in April - May. These crops requires warm climate for germination of seeds and maturation. Cold climate for growth of crops

**All time crops** are crops which can be grown at any time of the year. These crops will give the output in 1.5 to 3 months

# Types of Crops in India

## India is no. 1 rank in producing

- Rice
- Wheat
- Coarse Cereals
- Food Grains
- Oil seeds
- Sugarcane
- Cotton
- Jute

## India top 10 export share

1. Rice (21%)
2. Basmati rice (16%)
3. Spices (19%)
4. Cotton (10%)
5. Sugar (8%)
6. Fresh Vegetable (6%)
7. Coffee (5%)
8. Ground nut (5%)
9. Oil meal (5%)
10. Cashew nut (5%)

## India top 10 import share

1. Vegetable oils (47%)
2. Pulses (19%)
3. Fresh fruits (7%)
4. Cashew nut (6%)
5. Wheat (6%)
6. Sugar (4%)
7. Cotton (4%)
8. Spices (4%)
9. Misc. processed (1%)
10. Cocoa products (2%)

## Food Crops

Crops which are mainly grown for human primary consumption. All food grains pulses millets comes under food crops.



## Cash Crops

Cash crop or profit crop is a crop which is grown to sell for profit. It is typically grown for business intension.



## Plantation Crops

These plantation crops are high value commercial crops of greater economic importance and play a vital role in our Indian economy.



## Horticulture Crops

The word horticulture means garden cultivation. The crops which are grown under horticulture are fruits, vegetables and flowers.



### 3. Farming methods and implements

#### 3.1 Human /Animal powered farming operations

**Human power** is the main source for operating small tools and implements at the farm. Operations like soil preparation, weeding crop cutting, threshing, winnowing etc are done by manual labour. An average man can develop maximum power of about 0.1 hp for doing farm work. **Animal Power** farming is most commonly seen with marginal farmers and tribal farmers. An average pair of bull or ox can produce about 1 hp for usual farm work. Animals are used for ploughing, threshing, transporting. Animal dungs are used as natural fertilizers by subsistence farmers. Different farming operations by human and animal are shown below. Refer (fig1). (Pic 1, 2, 3) are few examples of non mechanised operation.

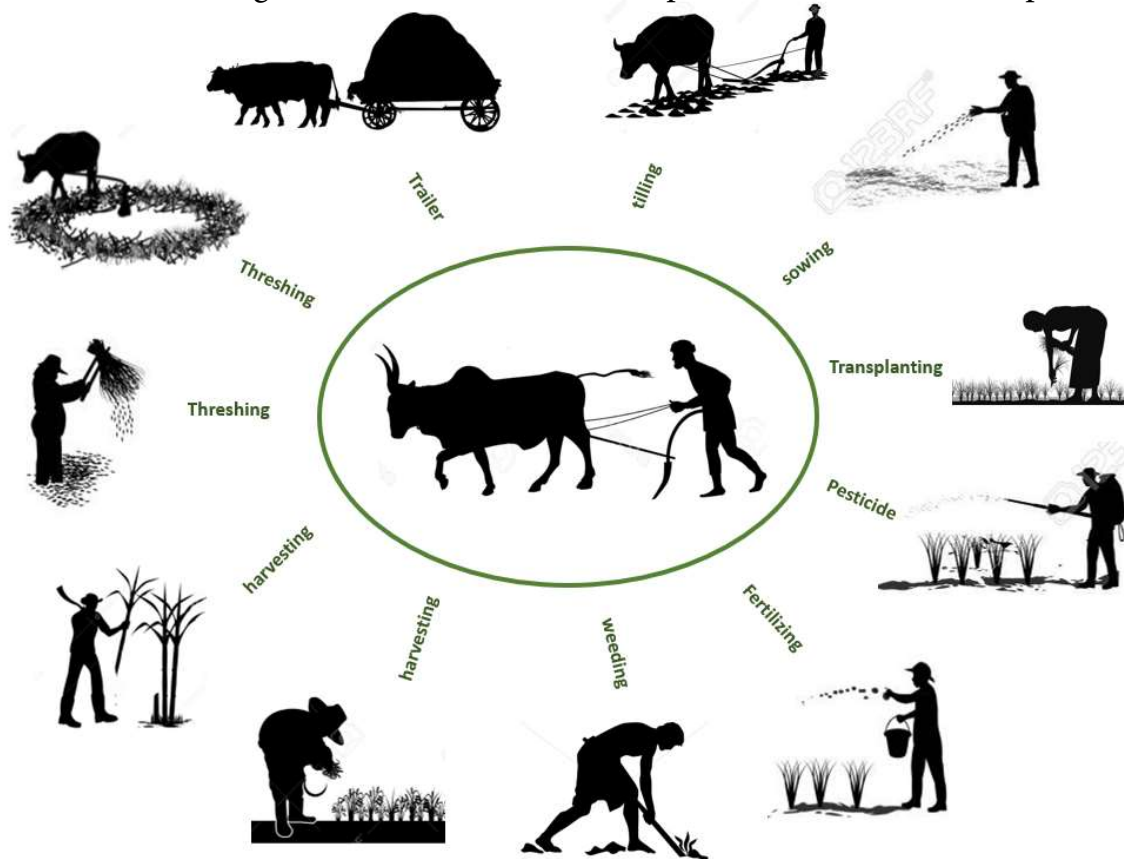


Fig 1



Manual soil preparation Pic 1



Animals used for wet soil preparation Pic 2



Manual harvesting using sickle Pic 3

### 3.2 Power tiller farming operations

Power tillers are also called as walking tractors. For power tiller government provide subsidy in all states of India, so that marginal and small farmers can afford it. Power tiller does almost all operation what a tractor does but with limited specifications. It comes with approximately 10 to 15 HP power range. Implements sizes are smaller than tractor implements. There is no draft sensing mechanism. The depth of cut controlled by self weight of implement. Few implements have a bench seat where the operator can sit and drive the machine. The below chart shows the various operation and implements of power tiller. Refer (fig 2). (Pic 4, 5, 6) are few examples of power tiller operations.

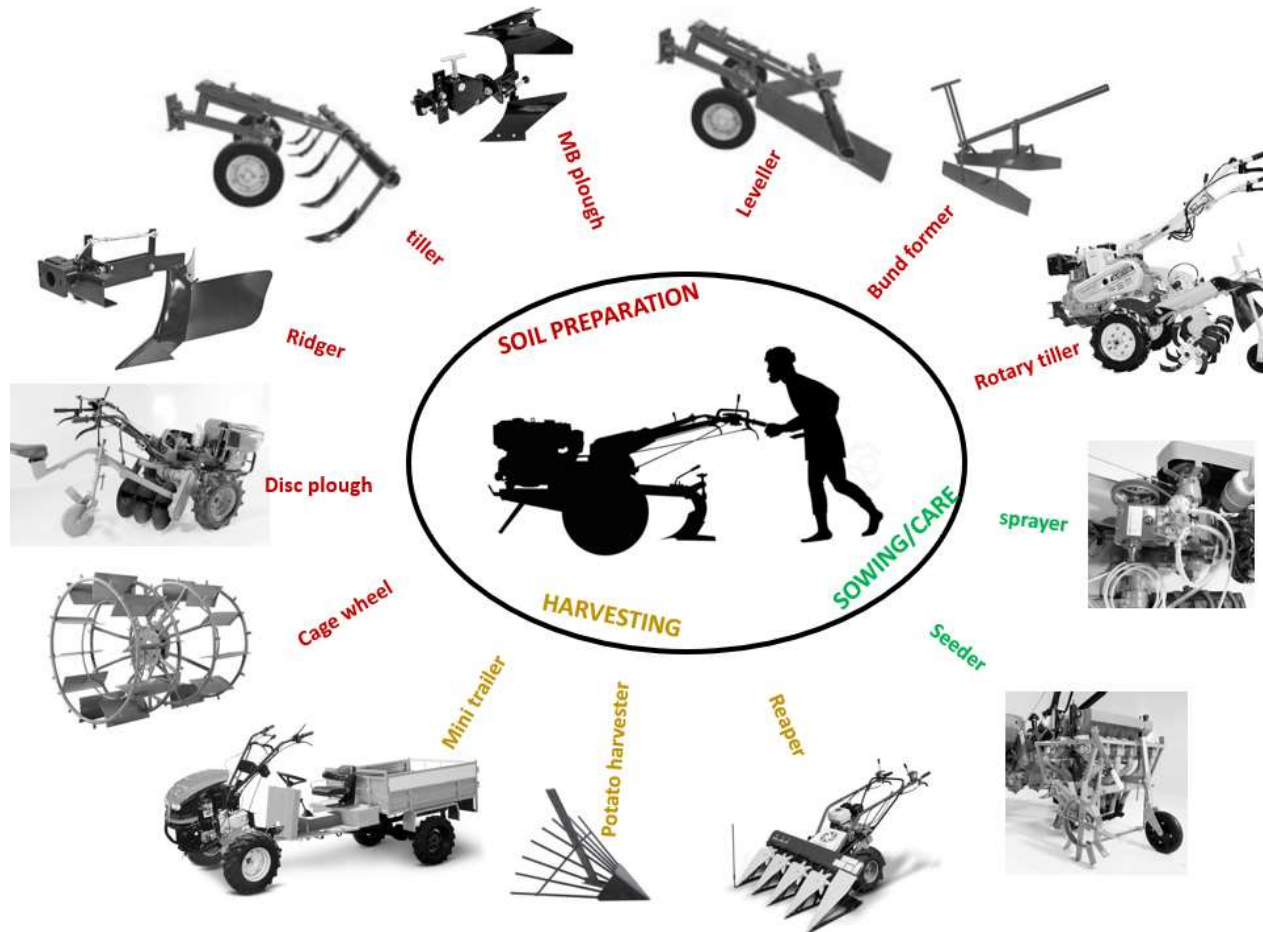


Fig 2



Power tiller with MB plough Pic4



Power tiller caged wheel puddling Pic5



Power reaper harvesting paddy Pic6

### 3.3 Tractor soil preparation implements

Tractors are mostly used for soil bed preparations. Different implement are used based on the soil type. Basically the soil is prepared under dry or wet condition which depend on the soil hardness and the crop which is planed to grow. For hard soil – MB plough, tiller and rotavator are used. For soft soils disc harrow and rotavators are used. In recent days Rotovator are used for all types of soil as it is a power implement and it pulverize the soil. There are trailed implements and powered implements. Half cage and full cage wheels are used for puddling operations. The below chart shows the various soil preparation implements which are commonly used in India. Refer (Fig 3). (Pic 7, 8, 9) are few examples of tractor soil preparation implements.

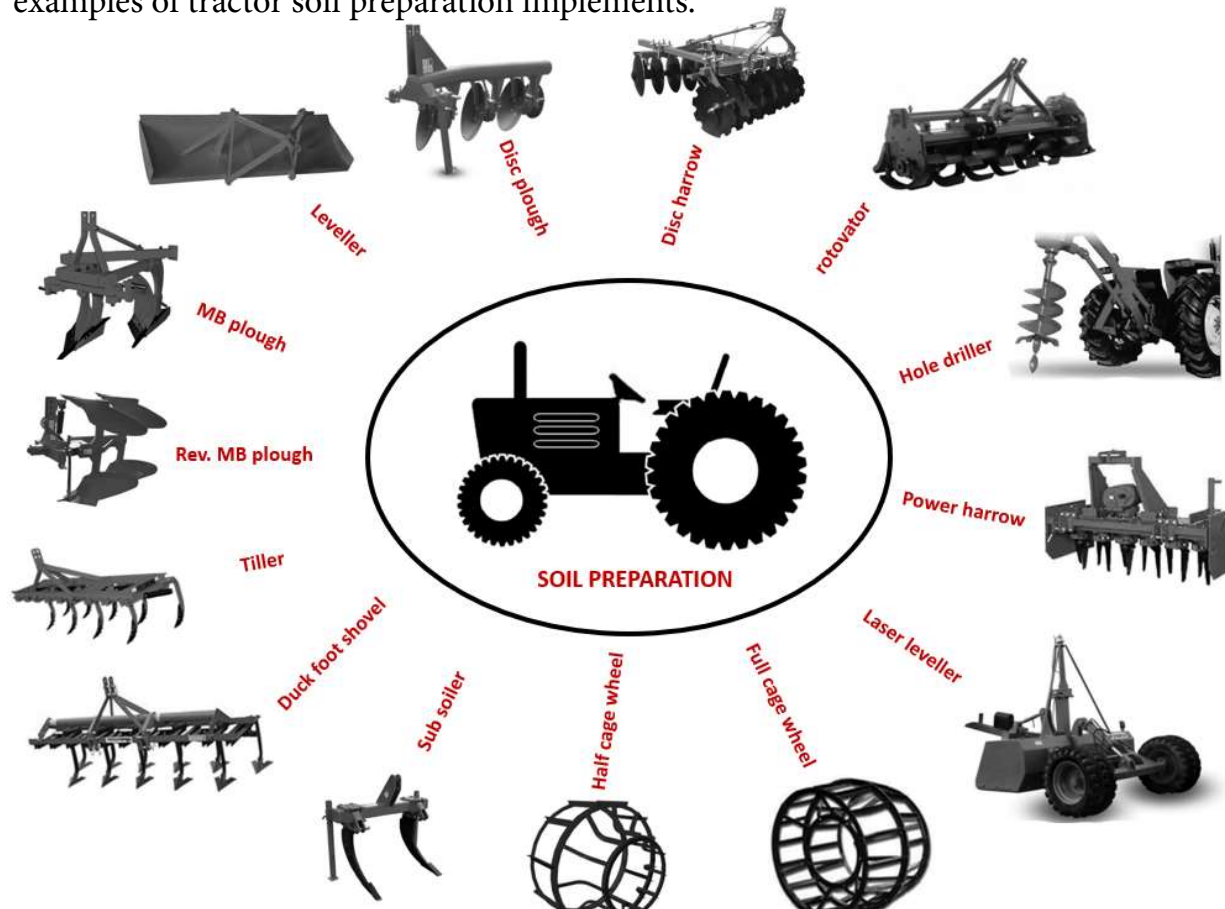


Fig 3



Primary soil preparation with rev. MB plough  
Pic 7



Rotavator used on dry land to pulverise the soil  
Pic 8



Puddling operation with disc plough Pic 9

### 3.4 Tractor planting / Crop care / Harvesting implements

The seed drill sows the seeds at equal distances and proper depth, ensuring that the seeds get covered with soil and are saved from being eaten by birds and being blown by the wind. This allows plants to get sufficient sunlight, nutrients, and water from the soil. Transplanting machines are slowly growing especial for paddy. Crop based harvesting implements are been used like paddy, wheat harvester, sugarcane harvester, potato harvester, etc. Grain based harvesting implements are front mounted operation. Root based harvesting implements are rear mounted operations. Below chart shows the various sowing, crop care and harvesting implements driven by tractor. Refer (Fig 4). (Pic 10, 11, 12) are examples of seeding, crop care, and harvesting operations.



Seed drill implement used to sow grains Pic 10



Tractor with spray irrigation Pic 11

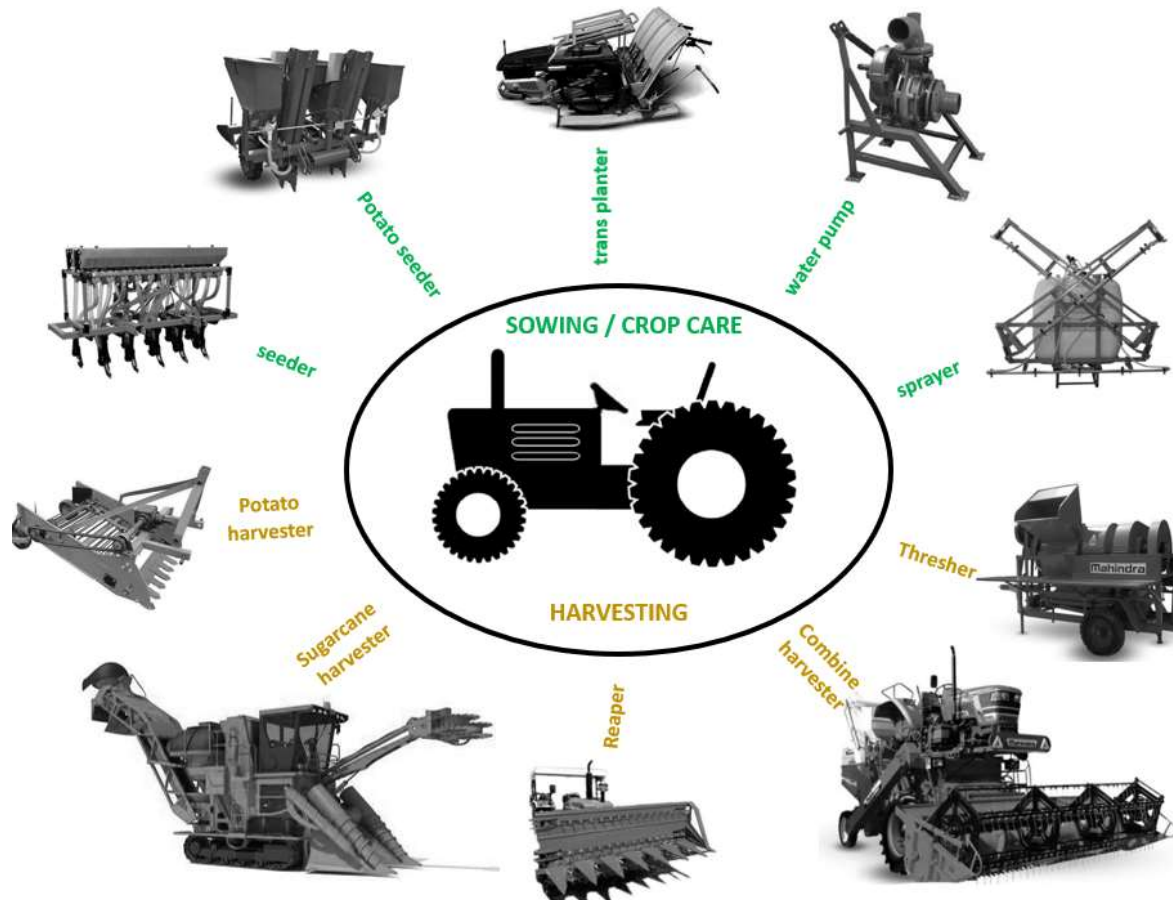


Fig 4



Combine harvester harvesting paddy Pic 12

### 3.5 Tractor post operation implements

Shredders, mulchers, balers, and trailers are the implements widely used as post harvesting implements. Trailers are also used for commercial purpose. Dozer, front end loader, back hoe, compressor are widely used for constructional purposes. Tractor manufacturers design specific tractors specially for haulage uses which gives better fuel consumption when compare to farming operations. The below chart show the commonly used the post harvesting implements and constructional implements. Refer (Fig 5). (Pic 13, 14, 15) are the examples of post operation implements.



Banana mulching operation Pic 13

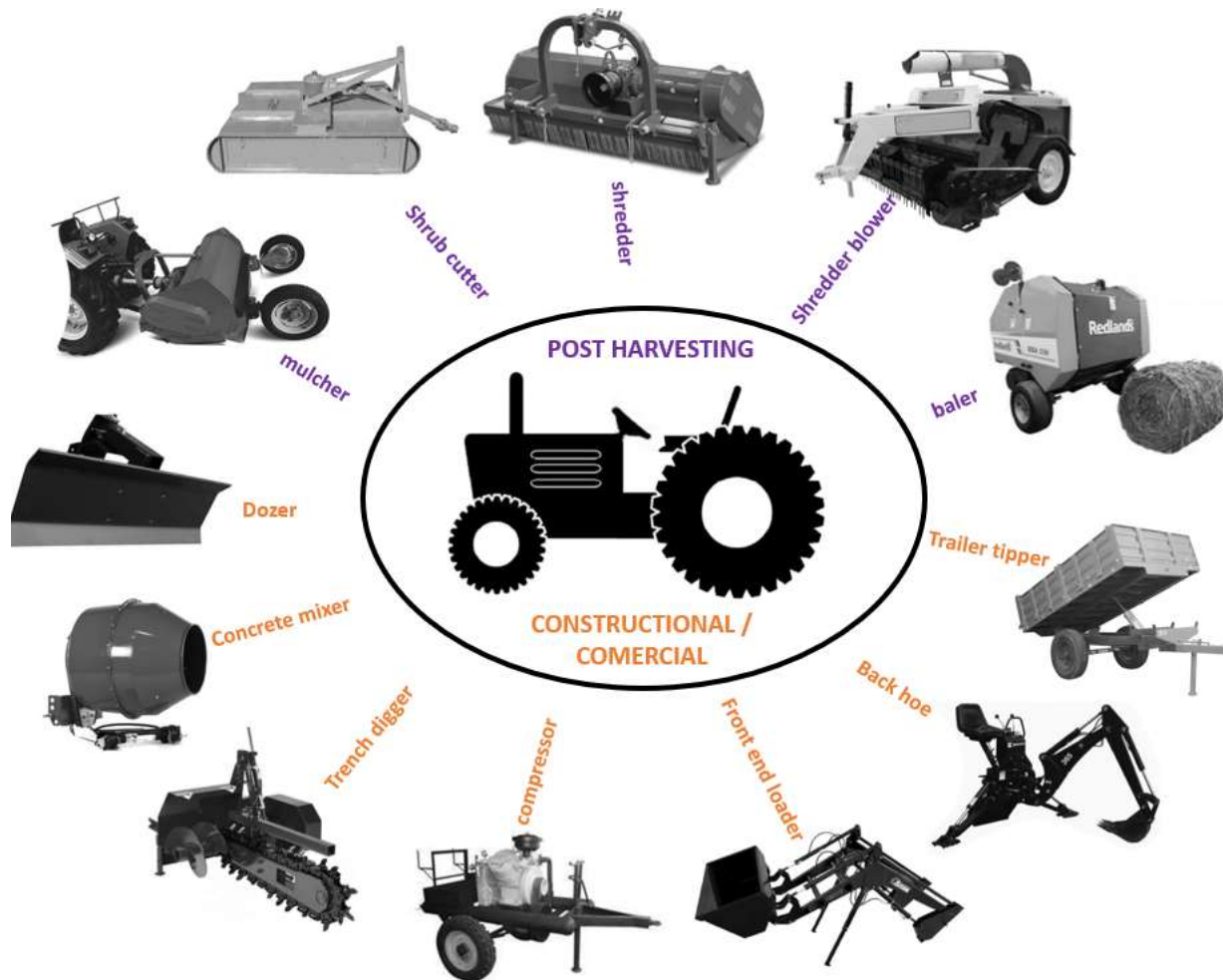


Fig 5



trailer loading harvested crops Pic 14



Front end loader for commercial purpose Pic 15

## 4. User Research with Sensitising kit

The main intension of conducting this research using sensitising kit is to understand the current farming practices by Individual farmers of a particular place through out the year.

### 4.1 Sensitising Kit

Farmer sensitising kit is a board where the user have to place the pictures of crops, soil type, farm machines, implements, across the year. The parts of kit are as follows:

1. Sensitising board
2. Soil type cards
3. Crop cards
4. Water resource cards
5. Main power cards (owned/Rented)
6. Implement cards.

### Sensitising board

It is a board where the farmer have to place the given choice of pictures. User details will be filled by researcher at the top, Farm area (ha) with slidable pointer to indicate the farmer's area, soil type , months, crops, water source,, farm power, primary, secondary, tertiary operations, post operation are entitled at the left most column. Against each title, boxes are drawn across every month. farmer have to place the choice of picture cards in respective boxes as per farmer's practice.

USER DETAILS													
FARM AREA (ha)				1				2				3	4
SOIL TYPE													
MONTH	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
CROPS													
WATER													
FARM POWER													
PRIMARY OPERATION													
SEC. OPERATION													
TER. OPERATION													
HARVEST OPERATION													
POST OPERATION													

Sensitising board

## Soil cards

Different type of soils in India like Alluvial, Arid, Red, Black, Saline, Desert, Mountain soil are shown and asked to pick the soil what the farmer have at their farm.

## Crop cards

crops which are grown across India are collected and categorised into kharif, Rabi, Zaid and all time crops. These crops are placed and asked the user to pick and place against the month when they use to cultivate.

## Farm power cards

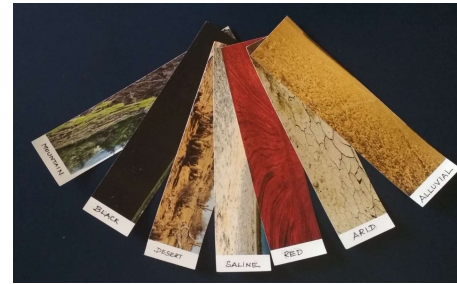
Common method to power the farm are human/animal driven, power tiller and tractor. Marginal farmer use to rent these machines when required. Orange bordered cards are rented options the other cards are own machines.

## Human/animal operations cards

All the conventional operations performed by human and animal are made as pictogram cards to place against each operations.

## Tractor and power tiller implement cards

Implement which are used for various stage of farming operations are collected and grouped into soil preparation stage, seeding/crop care stage, harvesting stage, post harvesting stages. User have to pick and place the implement which they use against various stage of particular crop cultivation. This is the last step of sensitisation.



Soil cards



Crop cards



Farm power cards



Human /animal operation cards



Tiller implement cards



Tractor soil prep. impl. cards



Tractor seeding. harvesting impl. cards



Tractor constructional. impl. cards

## 4.2 Insights from user research using sensitising kit with Marginal Farmers (Jawhar)

- User research conducted with farmers in Jawhar (Thane District), Most of the farmers are marginal and small farmers.
- Soil type at Jawhar – Mix of Arid and Black soil
- Farm size are very small also in steps (kind of terrace cultivation)
- They cultivate mostly wheat and paddy in Rabi and kharif season and vegetables and fruits in rest of the year.
- Most of the farmers use human or animal powered implements as they cannot afford machines
- Few farmers, rarely rent small machines like power tiller for some soil preparation applications.
- Water resource - Mostly Rely on monsoon rainfall, some time under ground water
- Mixed cropping is practiced during horticulture to avoid the risk of crop failure



Crops cultivated at Jawhar



During User research with sensitising kit



Typical farming practice by marginal farmer at Jawhar

### 4.3 Participatory research with miniaturised farm tool kit

The idea of participatory research with farmers is to extract need of new tools and implements through exploration of quick mock-up using below participatory tool kit. This unique tool kit is a miniature of a farm (1:10 scale) where group of farmers (four farmers in one group) will discuss about current problem in farming and solve it by making a mini concept model using below given items.



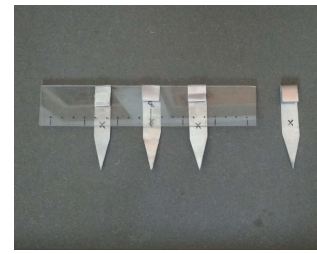
*Farm tray*



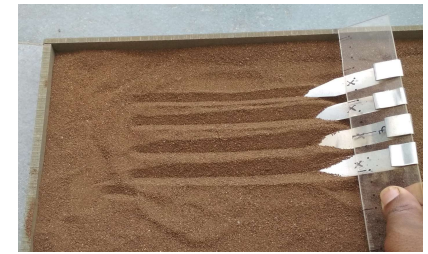
*Soil*



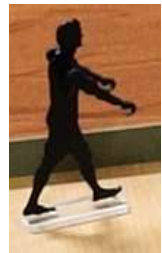
*aluminium sheet blanks*



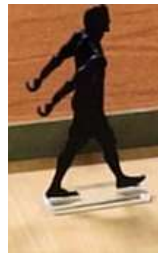
*Adjustable implement kit*



*Demonstrating soil preparation on miniaturised farm land*



*Farmer pushing posture (1:10)*



*Farmer pulling posture (1:10)*



*Pair of Ox (1:10)*



*Thermocol blocks*



*Paper straw*



*Steel wire*



*Paper cups*



*Card board*



*cutter*



*Stapler*



*Double slide tape*



*Tooth pick*



*Rubber band*



*Ball pins*

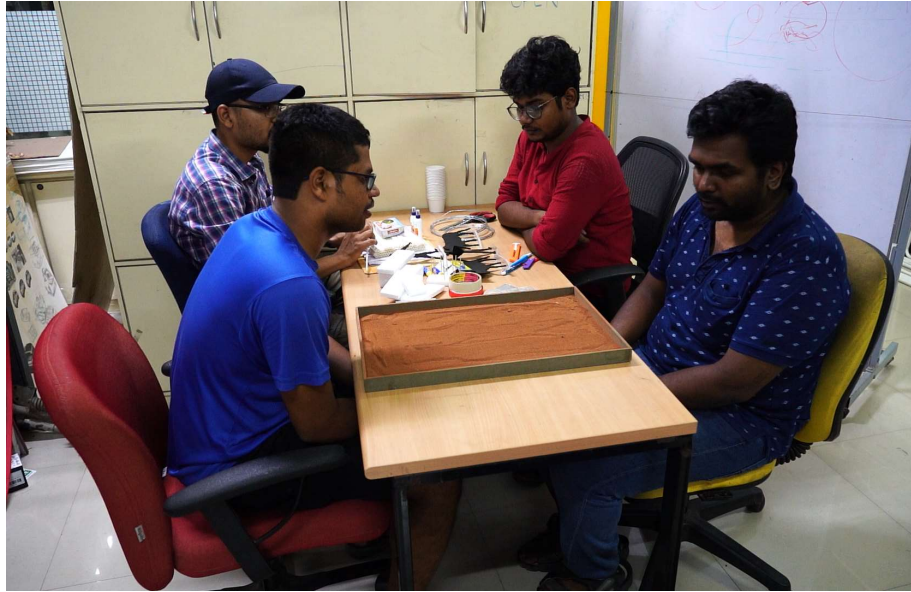


*A4 Papers*



*Stationaries*

## 4.4 Pilot Participatory Research with IDC students playing the role of marginal farmers



### Existing Problem

At present, on all ox driven agricultural operations, the ox is loaded at the front of its crest that acts as a point load. The load on ox is not properly distributed on larger surface area, which may cause fatigue in short time.



### Solution

The group came up with a unique solution. The implement is anchored with fabric belt, where the load is distributed over a larger surface area which makes the ox to feel less effort. So that the work efficiency can be better compared to conventional anchoring.

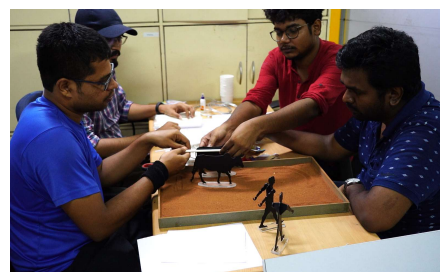
### Stages

1



*Group discussed about the existing problem with given ox model*

2



*Each farmer from the group suggested solution for the problem*

3



*One of the solution was finalised and the mock up model was made by all four farmers*

4



*The Group explained about the problem and the solution to the researcher.*

## 4.5 Participatory research with small and marginal farmers in Jawhar

### Briefing about the participatory research

- All marginal farmers assembled together and the need of participatory research was explained briefly.
- Four member Groups are formed with mix of gender and age group
- Each group were asked to come up with current problem while farming and asked to pick one problem and solve it through by making mock-up model using given tool kit.



*Marginal farmers, Jawhar*

# Participatory Research with Group 1



## Existing Problem

There are lots of medium size stones buried under the soil (3” to 4” deeper). These stones restricts the crops growth and yield. Currently there is no proper implement available to clear these stones.



## Solution

Ox driven land leveller with 4” scoop blades to pull the stones to the top surface of the soil which can be further cleared with other implement

## Stages

1



*Discussed about the existing problem on the given miniaturised farm land*

2



*Farmer from the group suggesting a concept in a demonstrative manner*

3



*Researcher (IDC student) helping the group in making the mock up model*

4



*Explained the solution with mock-up model*

# Participatory Research with Group 2



## Existing Problem

There are many stones on the surface of land after ploughing. There is no implement to clear the stones. And these are currently cleared manually which takes more time.



## Solution

Human driven implement with closely spaced rods acts as a broom stick which collects all the stones which are there on the surface of the soil.

## Stages

1



*Explaining the problem by planting the crops in a scattered pattern showing the impact on yield*

2



*A lady farmer suggesting a concept where a wider with series of vertical sticks can be pulled by both human or animal*

3



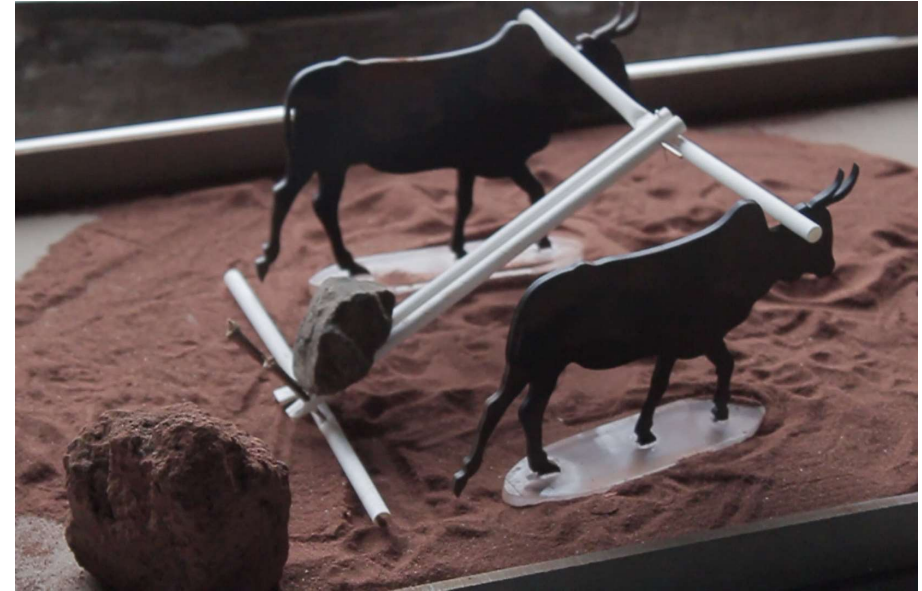
*Another farmer suggesting a steel made broom sticks with bend at the bottom.*

4



*Final concept demonstrated*

# Participatory Research with Group 3



## Existing Problem

When farmer do shifting farming, they use to clear the raw forest where the rocks need to be cleared. Currently it is cleared manually by rolling it inch by inch with help of levers and ropes. This takes long time to clear the rock from the field.

## Solution

Ox driven implement with adjustable stopper rods (span between rods can be varied by just placing the rods in right holes) Initially the rock has to be manually loaded over the implement. And then the ox can clear the rocks from the field.

## Stages

1



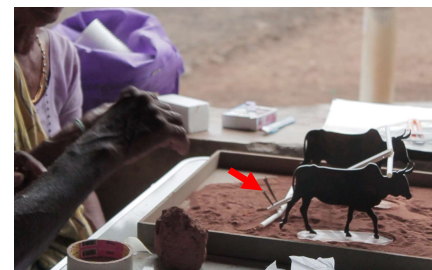
Group explaining about the problem moving the big rocks from the field

2



Making a structure for a ox driven concept

3



Using dry bamboo thorn as adjustable stopper (farmer took it from the bamboo fence)

4



Finished concept explained to the researcher

# Participatory Research with Group 4



## Existing Problem

The traditional method for transplanting the paddy crop is manual transplanting, in which the farmer has to bend all the time to plant the crop also slowly move rearward with bent posture. This causes back pain for many farmers.

## Solution

To avoid the bending posture during paddy transplanting process, this group came up with hollow pipe trans planter concept, in which the farmer has to just drop the crop at the top of the pipe in standing posture and by pressing the pipe into the soil makes the transplanting effortless.

## Stages

1



*Explaining the problem of transplanting where the farmer has to bend for long time.*

2



*Couple of farmers suggesting a solution together in which they propose hollow tube with some mechanism at the bottom*

3



*Researcher(IDC student) stepped in to help them in converting their ideas in to mock up.*

4



*Final model demonstrated to the researcher.*

## 4.6 Insights from participatory research with Marginal Farmers

- Participatory research was conducted with Marginal and small farmers from Jawahar (Thane District, Maharashtra). Each group of four farmers with mix of age group and gender was formed.
- Each group was asked to pick one particular problem that they face during farming. And instructed to solve the problem as a group with given participatory tool kit.
- Every group discussed the problem with themselves first and then conveyed to the researcher
- Most of the group explained about the problem using the given miniaturised farm tray, human and ox, plants, etc.. which was very much easy to visualize the problem.
- One out of four farmer struggled to make a mini mock-up, where the IDC student (researcher) stepped in to help them in converting their own ideas into a model
- Some farmer used their own instant material to build the model (E.g. One farmer used dry bamboo thorn from fence as an instant material). This particular act shows the involvement in participatory research.
- Female farmers came forward for the research, and the group gave importance to their suggestions
- Farmers made mock-up model very quickly (maximum 12 to 15 minutes was taken by each group)
- Over all the farmers felt very comfortable with this kind of participatory research and they could able to open up their ideas thru quick mock-ups.

## 5. Conclusion

User research with marginal farmers at Jawahar through sensitising kit, gave a pictorial representation of farming methods across various seasons of a year. This representation was useful for the researcher as well as to the farmer to understand the current farming practice and the gaps to be filled which will increase the farming output.

Participatory research using miniaturised farm tool kit helped users to mock-up their ideations with their farming knowledge to solve their existing problems. This methodology makes farmers to come forward to convey their problems and solutions in a demonstrative manner. Hence this research across India in future would help to collect many existing problems and ideations through farmers from different region, which can be further focused to design affordable, effective and context sensitive farming tools and equipment.

## 6. References

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## Image source

- Pic1 <https://countercurrents.org/2016/11/26/time-to-acknowledge-indian-women-farmers/>
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