Case-II: Device for improving the efficiency of laborers in cotton picking

(I) Introduction
The team took on a very important but challenging problem of picking cotton manually from bolls by laborers. They focused more on increasing the efficiency of manual labor instead of mechanizing the process of cotton picking. Since this was not the season of growing cotton, they couldn’t get firsthand experience of interacting with laborers and testing their prototype. However they had the opportunity to interact with two innovators Natubhai and Mansukhbhai, who have given their life for reducing the drudgery of laborers and making machines for picking and stripping cotton from bolls respectively. Both the innovators after multiple trials and iterations came up with their machines. The team worked in the workshop of Natubhai Wadher to make a small model of their idea for demonstration.

One of the factors discouraging the cultivation of indigenous varieties of cotton such as V 797 is the tedious post-harvesting process of removing cotton from unopened and semi-opened shells. Picking of cotton in hybrid varieties is easier because the bolls in the hybrid varieties open up at harvesting stage and sometimes the cotton even falls on the ground. The V 797 variety is extensively grown in many rainfed semi-arid parts of North Gujarat. The shells are removed manually before the cotton is sold to factories for ginning and pressing. While most families do it on their own, a few earn their living out of this job. A large number of old-people, women and children contribute to this labour (Honey Bee, 8(2):3-4, 1997).

One of the team members, Mr Bhargava Reddy comes from a family of cotton farming and hence he took this problem to work on during the summer school. Even though the team couldn’t come out with a working prototype, they got good insights of the process and feedback from mentors which will help them to build on their problem and make a prototype in the future.

“Design process is so detailed that we have got inputs, ideas and feedbacks from multiple directions. It would never have been easy without the design process. We would have never got to the prototyping stage” - Mr Bhargava Reddy

A very important aspect of this summer school was the process of in context immersion, which involves meeting people where they live, work and socialize and then immersing yourself in their context getting new insights and opportunities. Most of the teams that went on to field in and around Ahmedabad city underwent this process. This team got the opportunity to work with the innovator who had felt this pain himself before the dawn of a Cotton boll picking machine could come to him. Natubhai’s father had eighty acres of land. It was difficult for him to employ labourers for the entire farm and hence he used to support the labourers in plucking cotton from the fields. He noticed the labour shortage during the cotton picking season despite having a big team of sincere and committed labourers. Once while doing his work, the idea of making a machine to do the job crossed his mind.

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1 Feedback by Prof Anil Gupta: Major breakthrough in their problem statement is that even they are thinking of mechanism which can pick up cotton bolls and put it in bag. Focusing on affordability of farmers and efficiency of labourers. In case of complete mechanisation, judgement of labourers is not there, thus efficiency can be compromised. Productivity, quality, efficiency might be higher in this machine.
3 http://nif.org.in/innovation/cotton_ball_picking_machine/462
“I could not bear to see the problems of my father and other villagers. A lot of cotton use to get wasted. A machine would certainly make the job easier.” - Natubhai R Wadher

is something which drove Mr Bhargava to take up this challenge during this summer school. This was highlighted by the team in their problem sensed definition:

Cotton picking is done mostly by hands in India primarily by women. The main problem occurs in picking stage due to repetitive motion of hands, standing posture in hot conditions throughout the day. There are machines available in the market to harvest the cotton however these machines are not suitable for Indian context. This causes very serious health hazards like cutting hands, exposure to higher temperatures, bruises, back pain, heavy load carried by them. It also requires loads of time picking one boll at a time. This time can be well utilized to perform other tasks to live a better life. The load carried by them is usually more than 10 Kgs. This is a bag which is tied to their hip or carried in their hands. Workers go to fields in the morning to start picking and continuously work till the afternoon, after lunch they work till the evening. Basically an average person picks around 20-30 Kgs a day, that makes their wage not more than INR 200.

One of our team member’s has personally experienced this problem as his parents are in farming. He took it as a challenge and put forward his problem statement.

*Source: Final report submitted by Mr Bharagava Reddy, rakesh Choudhary and Ravi Sonkriya*

(II) Understanding the problem

Since only one team member had experienced the problem firsthand, the other two had to understand the problem and review the challenges in the current method of picking and also what is the need to design?

The team started with understanding the process and in which part the problem arises and how. They were first confused as to how to start, but with some literature review and session on problem mapping by Prof Shashank Mehta (NID), they did brainstorming and came up with analysis of the process.

Analysis of each step:

1. **Sowing seeds:**

Sowing of seeds is done by hand. It is a repetitive process of bending, putting the seed in the soil and covering the seed with soil. This often causes severe back pain & other muscle pains. Although there are many machines available in the market they often displace the seed causing the plant to grow in the undesired location.

2. **Irrigation:**

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*4 https://www.saddahaq.com/anol-gupta-at-uoh-sense-the-unmet-needs-of-society*
In this process the plant is watered, protected from pesticides and nurtured with fertilizers. During this process women & children are exposed to chemical fertilizers. According to WHO report 3 million pesticides poisoning & 20,000 unintentional deaths occur every year. The farmers store pesticides in their own house and use the empty vessels to carry water.

3. Picking:
This is the most important part of the process as the lint came out of bolls is picked during this stage. Cotton has to be picked in a specific period of time, otherwise lint drops off from the boll and the decreases the strength of the cotton.

4. Selling
This is the final process of the cotton growing. At this stage the farmer takes the cotton and sells it in the market.

The team had brainstorming session where they tried to define the Who, Why, What and How of the problem statement they have defined above. This will be important to understand the need to design before going in the field and getting the user context. The team tried to understand this in the following way as they had defined in their Problem analysis report.

Put yourself in the shoe of the other person. Deeply understand their need. Emphasize the extreme empathy. Write a screenplay of what you are going to do! How to make culturally acceptable solutions? One should try and understand the need. No solution is fit unless you try it. Go small, smaller & smaller and focus on the little things (Lecture by Sanjay.E.Sarma Professor of Mechanical Engineering, Former Chairman of Research and Co-Founder of The Auto-ID Center at MIT, Boston). Know whom to trust and whom to ask (Feedback by Prof Anil.K.Gupta Indian Institute of Management, Ahmedabad).

Source: PPAR report, Mr Bharagava Reddy, rakesh Choudhary and Ravi Sonkriya

(III) Defining the User Context: Interactions with Nathubhai
The team went to visit and work with innovator Nathubhai. The idea was to get inputs of the direction they are heading as well as work on their idea after getting feedback. The team explains their interaction with him in their report.

For our field visit we met Nathubhai Rathubhai Vader a farmer & innovator in village Erwada, Patdi, Surendranagar District, Gujarat who developed a cotton picking & stripping machine. He shared his views on cotton growing & picking. He said that 80% of the Gujarat farmers grow cotton. “V797” is the type of cotton grown in this area. He built a workshop on his own to develop and experiment on his machine. During the time of picking the cotton, many faced labour shortage. “Even farmers & their families would join the labourers to pluck the cotton. The shortage increased over time. Many labours go to a nearby industry to work who offered better wages. The cotton needs to be picked in a certain period of duration, otherwise the bolls fall of from the plant & get destroyed reducing the strength & hence the price. Then he got the idea of making a machine for picking the cotton. With the inspiration from villagers he was able to work on the machine and made it as it is today”, he added.
(IV) Ideation and prioritising solutions
After understanding the problem, the need to design and interacting with Natubhai, the team members started drawing sketches of the ideas in mind. Initially they were told to draw sketches of all the ideas in mind and then see which of them can be taken forward.

There are two perspectives of the problem. One is problems faced by labour as mentioned in the above sections, the other is the problem faced due to shortage of labours. So we have a question of “Do we design a device to increase the efficiency of the labours or do we design a machine requires no labour”. So we finally decided to design something that improves the efficiency of the labours & thus increase the productivity.

Source: Final report submitted by Mr Bharagava Reddy, rakesh Choudhary and Ravi Sonkriya
Ideally at this stage more time should have been spent on each idea so that one can have widest possible range of ideas, not just finding a dimple best solution. The best solution can be discovered later, through user testing and feedback⁵. The team however had a few ideas based on their problem understanding and feedback. They drew rough sketches of their ideas before it could be taken forward in the prototyping stage.

“After many group discussions, brainstorming, and feedbacks from mentors finally we moved to ideation process. The ideas we got in our mind were sketched on a chart and illustrated with process. Initially whatever ideas we have got we put them on the paper and tried to visualise them. From those feasibility comes next, because we are designing this for labour.”

⁵ An introduction to Design Thinking process guide, d school, Institute of Design at Stanford
time was a constraint, discussions and feedback at ideation stage didn't happen much resulting in some of the ideas getting buried. Discussion on each idea and their feasibility is important as it can help in building on the right solution for the problem sensed.

(V) Proof of concept and Prototyping

The team worked in Nathubhai's workshop to make a small demonstration purpose model of their idea. He helped them procure materials and guiding them for making a model of their idea.

The next day we have visited his workshop and discussed further on our ideas. He has demonstrated a model of cotton plant and illustrated the mechanism on which our model works & how the device should work. The cotton picking machine of Nathubhai was in the workshop so we have studied the whole process of that machine step by step. We gathered some material required for the prototype in the workshop itself. We got a box made of iron. We cut & welded it according to our model and made a gallery so that the tree can pass through. This was just a start.
The team worked on two models for showing their ideas.

The team went to Mansukhbhai Patel, who has made the cotton stripper machine. This stripper saves cost involved in manual labour and eliminates drudgery for women and children. It processes 400 kg cotton per hour. It improves the quality of cotton. The machine is available in two models. It is available with suction feed as auxiliary attachment.

As this is not the season of cotton we had to make virtual cotton plant and stick cotton bolls to it. We run the machine with hand through the cotton plant and as expected. The machine collected the bolls of the cotton.

Source:
https://drive.google.com/file/d/0B7CBrHy6SxFAY256SnA3bGVHOVU/view?usp=sharing
Mansukh Bhai Patel: (Conversation)

(June 23, 2015 15:00 Hrs) Viramgam

Q. Kya hamara product haath se chala skta hai kya?
A: Kar skta hai par jayda takat lagani padegi aur jayda majdoor lagane padenge. Waise agar koi chota engine lagaye to accha hoga.

Q. Cotton ki 2 rows ke beech me kitna gap hota hai?
A: Aisa fix to hai nahi par 4.5 se 6 feet ke beech me hi hota hai.

Q. Hame iss cotton bolls nikalane ki machine bnane ke liye kya dhayn me rakhna chaiye?
A: Aap log pahle manual process ka video dekho aur manual ki tarah hi mechanism is machine me laga do, tumahara idea ban jayega.

Q. V797 cotton ko kitni bar pick krna hotter hai?
A: Agar bina irrigation ke ho to 2 bar aur irrigation wali ko 4 bar pick karte hai. Agar ek bar pick karni hai to puri fasal ko pakne ka intzar karna hota hai par tez hawa se cotton kharab ho jati hai aur roj (Name of an animal) bhi cotton kharab kar dete hai. To 2 baar hi thik hota hai.

Q. Kache aur pakke cotton me basically kya farak hota hai?
A: Kacha asani se nahi girta par pakka plant ko thoda hilate hi gir jata hai. Aur kacche ka diameter 0.75 inch aur pakke ka diameter 1.25 inch ke lagbhag hota hai.

Q. Aapke anusar hamare model me kya aur hona chaiye?
A: Ek to gripped belt lagao jo ki plant ko move karega aur wo cotton ko bhi rok ke rakhega .baki ek baar bana ke pata lagega ki kya hota hai. koi bhi machine aise ek baar me successful nahi hoti usme bahut modification chaiye hote hai. Aur jarurat ke anusar upgrade karne par hi machine thik banegi.

Q. Kya hame is model ko continue krna chaiye?
A: Haan bilkul. Ek baar banao tabhi pata lagega ki kya modification chaiye. Ek bar banao aur usko analyze karke ki kya mistake hai .fir modify kro aur fir analyze kro. Tabhi product safal ho payega.

Source: Prototyping process report submitted by Mr Bharagava Reddy, rakesh Choudhary and Ravi Sonkriya
Feedback from the labourers is important. The team members realised this, but they documented the process so that it will be easy to re-look and start working on the idea again.

As mentioned earlier in this report one of our team members parents are in farming. This allows him to explore more of cotton field and get more insights from his field. Workshop is available in the village where he lives so fabrication is not a concern. Testing would be done once the crop grows and cotton bolls grow to their stage. This would generally be in October or November, by then the prototype we be ready for testing. Financial support will be needed and product support will be taken from farmers in his village and other intellectuals.

Source: Final report submitted by Mr Bharagava Reddy, rakesh Choudhary and Ravi Sonkriya

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8 Feedback Professor Prakash Vani: He said that cotton bolls are in all direction on the plant so difficult to collect all bolls using this machine.
Professor Dilip Joshi: He asked, “Will the plant be damaged after picking cotton bolls from this machine?”
Professor P V M Rao: He said, “Your problem is more challenging as compared to other teams so it would require more efforts.” So he told them that even if they are able to solve part of the problem it would be great.