

INDIGENOUS PRODUCT DEVELOPMENT BASED ON CONTEXTUAL INNOVATION AND LINK TO MARKET

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ABSTRACT

There are large numbers of products locally innovated to suit particular context. However these are never available in the market in absence of their commercial manufacture that can be mutually beneficial to innovators and users and also to Micro, Small & Medium Enterprises (MSMEs). This is attributed to lack of product design capability of most of the MSMEs that could have rendered required support for making the innovations commercially feasible and marketable products/ services. National Innovation Foundation (NIF) started functioning in March 2000 as India's national initiative to strengthen the grassroots innovations and outstanding traditional knowledge. It has scouted, documented and put its efforts to bring grass root innovators innovations to market. As a measure to cover the entire country, National Innovation Foundation- North East (NIF-NE) is housed in Indian Institute of Technology Guwahati (IITG) as collaborative effort. Department of Design (DoD) at IITG has been supporting NIF's effort by providing design inputs to make these innovations available to the people for social benefits and positive impacts.

Due to acute shortage of tea garden labourers, Tea planters' associations and Tea Board have approached IITG for designing appropriate mechanized systems to solve the plucking problem, involving fewer labourers. NIF also had floated a national level competition for design of a manually operated tea plucking machine as a national challenge and socially relevant technological intervention. Design research involving research scholars from the Department of Design, was initiated as a response to solve the problem of tea plucking. Design of two tea plucking machine was carried out; one manually operated and the other electrically operated. Acceptances of these machines by the beneficiaries were studied.

Both have given very positive results and these works has established the vital contribution of design for bringing these innovations to market.

Keywords: Contextual innovation process, entrepreneurial, indigenous product development, design practice, design and technology transfer

1 INTRODUCTION

Tea is the unofficial national drink of India. India has a long history for cultivation of tea for consumption as stimulating beverage as well as an ingredient in traditional system of medicine. Commercial production of tea in India started with the arrival of British East India Company in Assam. Presently Tea is a major beverage in India and it along with China is the largest producers as well as consumers of tea. 70% of tea produced in India is consumed in India itself. Tea is grown in places having sufficient rain in most part of the year. Hilly terrain is preferred for tea plantation since water logging can be naturally avoided. Tea manufacturing involves processing fresh tea leaves. The tea leaves are plucked from the plant known as *Camellia Sinensis* and then processed in factory. To get high quality tea only the buds including the third leaf has to be plucked and processed. In North East India plucking of tea leaves are mainly done by women and hence it is mostly the women that have to undergo the drudgery. Tea leaves harvesting requires experienced eyes and dexterous hands. An experienced plucker will pluck around 40kg of tea leaf per day. Plucked leaves are collected and taken to the factory for processing. All over the history of tea cultivation, the one input that was always in short supply is the manpower for plantation work including harvesting. Cost of labour is also the most expensive component in tea produced. In spite of this, tea garden labours were not highly paid. Labour shortage has been aggravated in recent times. Migration of the new generation of

tea community people with better education and job prospects with better pay in other domain is leading to shortage of workers in tea harvesting sector. Management is not able to engage adequate number of workers for plucking tea leaf during peak season. Tea Companies are incurring huge loss since they are unable to harvest the tea leaves on time. In this scenario the tea companies are looking for effective alternative solutions; as a result, mechanization of tea leaves harvesting appeared to be evident. Stake holder such as Tea planters' associations and Tea Board have been scouting for mechanization and looking forward to countries premier institutions like IITs to provide viable solution and thus approached IITG for designing appropriate mechanized systems to solve the plucking problem so that fewer labourers need to be involved. NIF with its mission to help India become a creative and knowledge based society by expanding policy and institutional space for grassroots technological innovators is propagating the Grassroots to Global (G2G) model to change the way the world looks at the creativity and innovations at grassroots and bring innovations to the market with an explicit aim to reduce time to market from concept so that common people are benefited. In order to change the existing tea plantation's plucking situation through Gandhian philosophy, NIF had floated a national level competition for design of a manually operated tea plucking machine involving grassroots innovators as well as scientific community.

Emphasis of current research is about tea leaves harvesting methods and for developing new tea leaves harvesting machine which will be more efficient & eco friendly. The shortage of workforce and the increase in manpower cost paved way for efficient process of tea leaf harvesting through machines even in Assam. Tea leaf harvesting machine helps in increasing the output rate of harvesting with reduced man power and production cost. Since India is one of the major producers of tea in the world, tea leaves harvesting machine will have an important role in improving the tea production with reduction in cost. Main problems encountered in currently available machines in the market can be summarized as – lack of quality harvest, high cost of the machines, fumes and smell and high noise levels of petrol operated machine, body pain due to overweight etc. A petrol operated machine consumes 600ml of petrol per hour.

The doctoral research scholars from Department of Design, Indian Institute of Technology Guwahati choose to take up the challenge of designing tea plucking machines as a part of academic endeavour forming a part of their doctoral thesis. Emphasis was on creating socially relevant design intervention through academic design institution as a part of design education offering. IIT Guwahati offers BDes, MDes and PhD in design.

2 PROBLEM STATEMENT

Tea cultivation is a major industry in Assam contributing to maximum numbers of employment to its population and is a very important socio-economic factor. This industry facing shortage of labour due to non-remunerative engagement in changing scenario has posed a challenge to the entire state in various directions. This can be changed with technical intervention in terms of mechanizing tea plucking operation. Due to age old plantation having different variations in plantation such as single hedge, double hedge, undulating terrain, there is no common solution to the plucking problem for the entire state. This is also aggravated by types of plantation like organized tea estates and small tea growers. Thus problem statement can be stated as design, development and commercialization of a tea plucking machine that is environmental friendly based on experience of the industry in Assam in mechanization.

3 LITERATURE REVIEW

Literature survey and review was carried out to gather information about tea leaf harvesting both in conventional way and through mechanized means, and also studied the scope of design intervention in pre-processing of tea specifically tea leaf plucking.

3.1 Mechanical harvesting of tea in Central and Southern African region

During early 70s, due to man power crisis, the tea companies of Argentina introduced mechanize tea harvesting system. Later on African tea growing nations also introduced mechanized harvesting. Tea industry tried to use shear Plucking but the quality of the tea produced through shear plucked leaves were not good. Moreover the Tea bushes were damaged after applying shear pluck method that also damaged the maintenance leaves.



Figure 1. Manual tea plucking shears



Figure 2. Manual shear tea plucking machine

3.2 Comparison of Shear and Machine Plucking In Tea

Comparative data available from Tea Research Association, Tocklai, regarding shear and machine plucking of tea is summarised below:

- Yield at 9-11 days interval in shear plucking and at 13-15 days under machine plucking was similar to that of hand plucking at 7 days interval.
- Under shear plucking, the harvest contained maximum standard shoots at 9-11 days intervals and minimum damaged shoots at 13 days interval.
- Increase in productivity was highest under unprune in both shear and machine plucking.
- Increase in productivity ranged between 38-50% under shear plucking at 9-11 days round.
- It ranged between 227-438% in case of machine plucking at 9-14 days Intervals.

It is observed that properly taking care, machine plucking can still be a viable option in terms of productivity although not in terms of quality specifically when end product is orthodox tea.

4 PROBLEM IDENTIFICATION

4.1 Market Study

Tea leaf harvesting machine reduces the effort of a labour during plucking. It helps in increasing the output rate of tea harvesting with less manpower. An intensive market study was carried out to find out different types of machines available in the Indian market exclusively for harvesting tea leaves. This provided understanding about the different manufacturers' tea leaf harvesting machine in India as well as abroad. The study was very helpful and provided information like manufactures of tea plucking machines with various harvesting capacities, existence of different types of models, various features of these machines like, weight of the machine, easiness of handling, clear vision of the process, cleaning, average product life, servicing, maintenance procedures etc.

4.2 Product Study

The idea of introducing tea leaf harvesting machine is to increase productivity with minimum manpower engagement. There are various types of machines available in the industry like fossil fuel operated, single person battery operated etc. In case of hydrocarbon fuel operated machines, cutting motion is produced by the prime mover for cutting process and a blower also operated through the engine is used to blow the cut leaves into a bag. The battery operated machines have a harvesting capacity of 30Kg/hr. weighing around 3.2kgs along with the battery. One part of this study focused on Battery operated machines. The source of energy in battery operated machines is a 12v 7.5 Ah battery. A DC motor connected to the battery and this generates rotating motion. Rotating motion from the motor to the rotor shaft is achieved with the help of gears. The rotating blades cut the tea leaves. The metal plate that is connected to the axis of the blade transfers the cut leaves to the attach bag which can be easily emptied.

The problems in the existing battery operated machines are:

- a. Desired quality pluck could not be obtained due to non-selective plucking.
- b. Some machines damages the tea table
- c. Most of the machines are not designed ergonomically; due to this user found it uncomfortable.
- d. Cutting width is less to even cover single row of tea bushes.



Figure 3. Kawasaki two-man tea harvester SV120



Figure 4. China made tea plucking machine



Figure 5. China made self-propelled automatic Tea plucking machine



Figure 6. Battery operated tea leaf plucking machine

4.2.1 Product Design Specification (PDS), manufactured by Ktech Engineering, India

Table 1. PDS

Product Name	Tea Leaf Harvesting machine
Target User	Tea Pluckers of North East India
Usage	Outdoor
Type	Portable
Weight	About 3.2kgs
Working duration	8 hours with full battery
Material of construction	Body – Fibre Reinforced Plastics (FRP) Rotor – ABS/ PC, Handle – ABS/PC
Life	10 years
Methodology- Product Design	Rapid tooling using reverse engineering techniques.

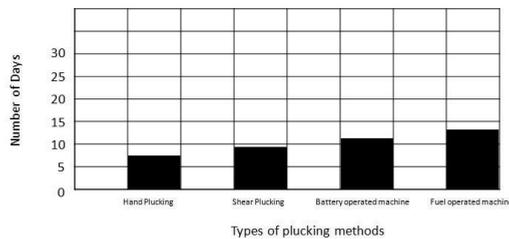
4.2.2 User Study

During the process of data collection an in depth user study was carried out. This study was not only limited to ergonomic aspects but Socio – Cultural information of the end users were also carried out including the task of user need analysis. As suggested by the users the fossil fuel operated machines having high fatigue factors; also the problem arises during plucking on uneven ground.

4.2.3 User Requirements

Motorized device is preferred for having selective plucking capability, less weight, high production rate, easy to operate, all weather compatibility, low noise.

Table 2. Interval between harvesting in different methods



4.2.4 Key findings for battery operated machines from Market

- Price of the machine ranges from Rs 8,000 to Rs 12,000

- Labour saving ratio of 1:4
- Covers up to 150 bushes/hour
- Harvesting capacity of 30 kg/hour
- Average Machine weight: 3.2kgs
- Not much importance has been given for ergonomics and aesthetics

5 METHODS AND METHODOLOGY

- Literature review on Tea leaves harvesting machine was carried out by referring books, magazines, journals and other related documents.
- Data collection was done by user study and market study through interviews, images, videos
- Concepts was generated by sketching, adopting various concept generation techniques like brainstorming, mind mapping etc.

6 CONCEPT GENERATION

Area of design research is based on the actual needs of the tea industry. Agency like NIF also come forward to engage innovative minds and solving this problem and initiated a competition for design of manually operated tea plucking machine. Thus based on these two objectives, designs of two types of machines were initiated.

6.1 Battery operated tea plucking machine

Emphasis given for Battery operated machines was to increase its efficiency by enhancing its plucking width and transferring the weight of the motor to the back of the plucker's body like the battery and transferring the control of the machines to both hands to reduce fatigues and improve controls. In most of the available machines the numbers of rotors are six. The performance of the machine can be increased by introducing more rotors in terms of coverage of the plucking area. In the same time we have to keep the weight of the machine on hand constant.

6.1.1 Detailed design of battery operated tea plucking machine

After brainstorming & mind map generation the solution was found. In present machines the Prime mover i.e. the DC motor & associated gear mechanism is attached with the machine itself. This heavy part can be shifted to Battery Backpack and the rotary motion can be transmitted to the modified hand held machine with the help of flexible shaft mechanism and the details are shown below.

The existing ABS / Polycarbonate casing was replaced by FRP and the numbers of blades per rotor were increased from two to four. The length of casing has been extended so that more rotors in each machine can be accommodated. Compared to the existing machines having six numbers of rotors, in the new design, it has been increased to sixteen. During design process reverse engineering along with rapid prototyping and tooling method & technique were adopted. The diagram provided below shows the modification of the rotor blades.

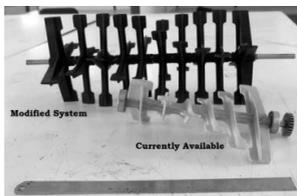


Figure 7. Comparison between present & modified rotor system



Figure 8. Modified battery operated harvesting machine

6.2 Manual tea plucking machine

The preliminary design of the manual tea plucking device was intended to establish an overall concept for the project and served as guideline for detailed design. As a first step in preliminary design, an attempt was made to design and develop a tea plucking device suitable for drudgery reduction with due consideration for ergonomic aspects, portability, ease of operation, clean and easy to maintain, less in weight so that it used easily. Tea collection bag may also be incorporated in the same so that

women do not need to carry it on their back. In this attempt, it was assumed that if ergonomics and light weight appealing CAD modelling based manual tea plucking device having sufficient safety with full cover over operating space suitable for users, there will be sufficient demand for it to be manufactured commercially. During the design of individual part, its specific location and function in subsystem in relation to fit in overall system goal needs to be considered, its shape, its material, its surface treatment and interface with the component.

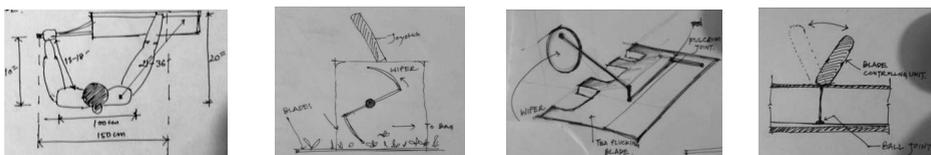


Figure 9. Human dimensions of workstation design, wiper working mechanism, joystick like lever mechanism for controlling the blades

6.2.1 Detailed design of manual tea plucking machine

The shape of manual tea plucking device (Figure 9) is rectangular box and size of the device is 1000 mm, 450 mm for handle and 550 mm for actual plucking mechanism. This device is having better cutting efficiency with human power having less fatigue for the operator, weigh less so that it can be used easily, tea collection bag also incorporated in the design so that women do not need to carry plucked tea leaves on their back. Two hardened carbon steel blades connected with a joystick like handle that can work on both sides, right and left. Greater plucking area is covered by less manpower and it plucks at least three times in capacity (output: tea leaves plucked/unit time) as compared to human effort with hand alone. A pair of top and bottom sliding blades pluck tea leaves. Then leaves are pushed by 'S' shaped wiper and collected in a bag at the rear part of the machine. The construction materials are easily available across the country which is made by thin stainless steel, rubber and plastics. Flexible round pipe provided in the device which can support the machine with the operator's body. It is cost effective and thus is not a burden for tea plantation owners or welfare committees to purchase this device.

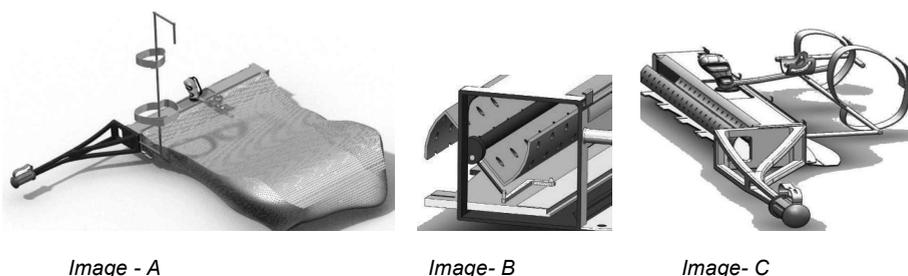


Figure 10. View of manual tea leaf plucking machine and tea collecting bag with flexible height adjustable support (Image-A), wiper fixed with fulcrum joint which is connected with plucking blades (Image-B) and ergonomic joystick like operating lever (Image-C)

7 COMMERCIALIZATION

Commercialization of the product will be done through collaborative effort between IIT Guwahati and various Tea planters' associations of North East India. Initially prototypes will be introduced in various tea gardens of North East India under different operating environments and performance feedback will be collected and further modification / improvement will be done at IIT Guwahati. The final commercial model will be launched on royalty sharing basis through technology transfer between Micro, Small & Medium Enterprises (MSMEs) and IIT Guwahati

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