Grassroots Innovation to Enterprise

A Case Study on

Motorcycle Driven Ploughing Machine

Gujarat Grassroots Innovations Augmentation Network (GIAN)

www.gian.org

Index

Introduction

With introduction of summer groundnut crop in the region increased the demand of draft power which forced the farmers to search for economical alternatives. Also increasing frequency of drought, decreased supply of fodder, restrictive usage of bullocks, high maintenance cost of draft animals added to it. Whereas tractors were found uneconomical for later stage (when the soil has considerably softened) for ploughing and inter-culturing, weeding due to high weight and fuel consumption, triggered the innovator.

It is a simple multipurpose toolbar which attaches to vehicles like Enfield Bullet Motorcycle by replacing the back wheel. It is an innovation by Shri Mansukhbhai Ambabhai Jagani, Amreli. The innovation was scouted by Mr. Mahesh Parmar, SRISTI

For farming operations, tractor is not an affordable option for farmers having small land holdings. Increase in the cost of fodder for bullocks, regular occurrence of drought and shortage of farm labor forced the farmers of Saurashtra area of Gujarat to look for an alternative to Bullock. Inspired by a local mode of transport, the three-wheel taxi "chhakdo" (common transport in the Saurashtra region), innovator has developed an innovative multipurpose farming machine which can do all the operations which can be carried out by a pair of bullock.

Using the self fabricated chassis, drive and power of an Enfield Bullet motorcycle in front the innovator has retrofitted an attachment with two wheels at the rear with a tool bar to fit various farm implements. The rear wheel of the motorcycle has been removed and an innovative assembled unit has been attached. It can also be designed and attached to locally available Chhakdo rickshaw or assembled vehicle having minimum 6.5 HP engine. This meets various needs such as ploughing, weeding and sowing seeds and spraying. It can improve productivity and reduce operating costs for farmers, who currently use bullock-driven plough and cannot afford the tractors or power tillers.

The Product: Key Competitive Advantages

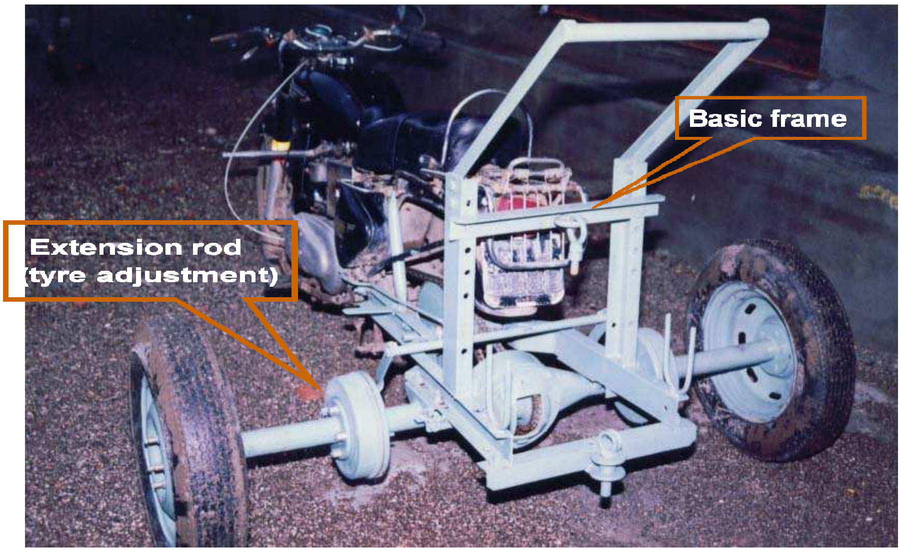
- The device was developed by an Indian artisan cum farmer and has already proved its utility.
- Ideal for a wide range of agricultural operations like field preparation, Sowing, Inter-culturing , Spraying etc
- It is simple, easily repaired and requires low maintenance, in contrast to tractors
- No continuous variable cost, in contrast to bullocks
- Comparable price to bullocks
- Attachable to "ENFIELD" and some other motorcycles.

Salient Features and advantages

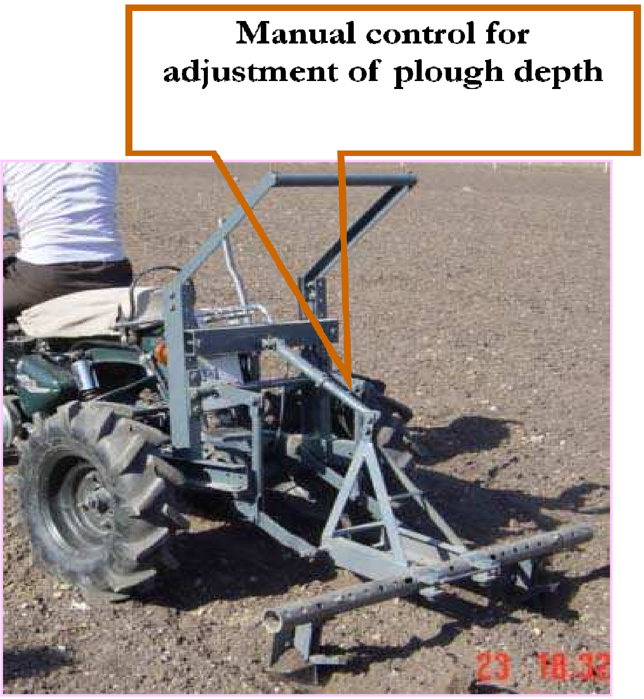
- Ideally suited to farmers with small and medium size land.
- Stronger and 3 times faster than bullocks
- Far cheaper than tractors
- Simple , cheap and low maintenance
- Can plough an acre of land in an hour consuming only about 0.5 liters of diesel.
- Multipurpose device can be used for agriculture operation, transportation and also used as regular motorcycle.
- Novel & Patented in India & USA

Product Development

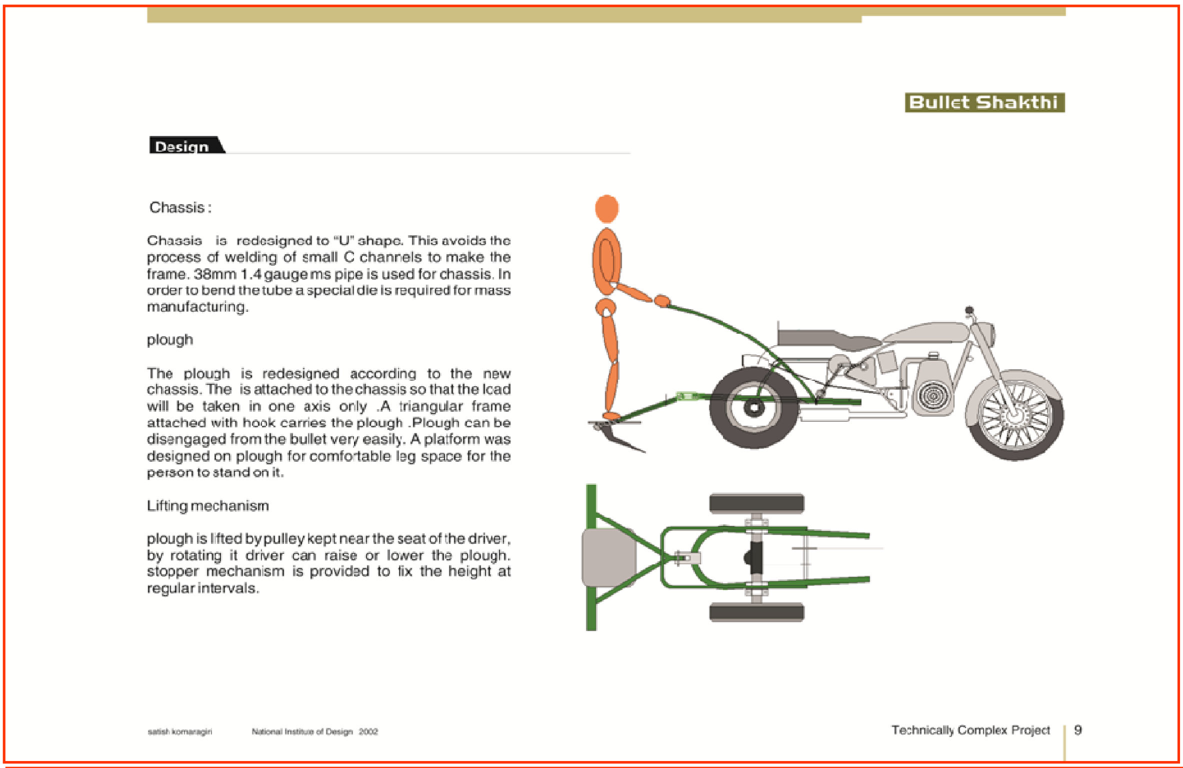
P1 – First prototype by Innovator (1994)

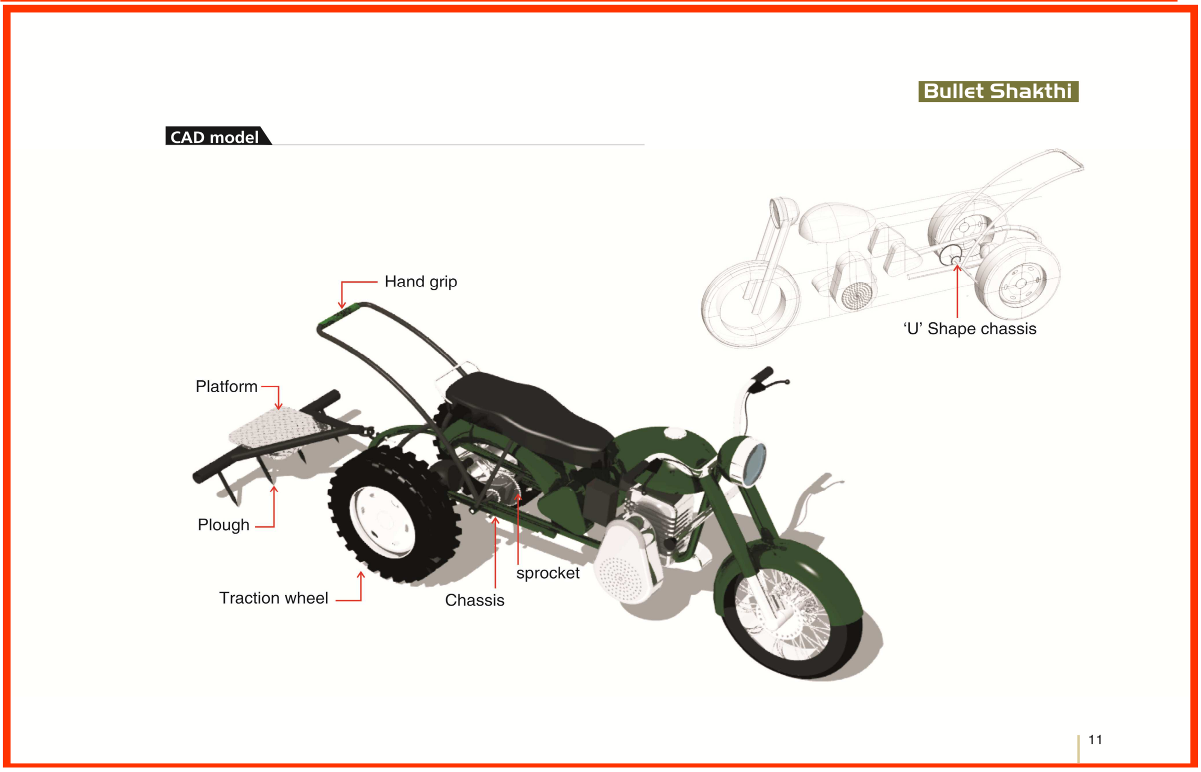


P2 - 2nd Model by the innovator with added features (2000)



P3 – Involvement of formal science - design inputs from NID





Advantages: (Prototype 3)

Better in ergonomic and aesthetic consideration

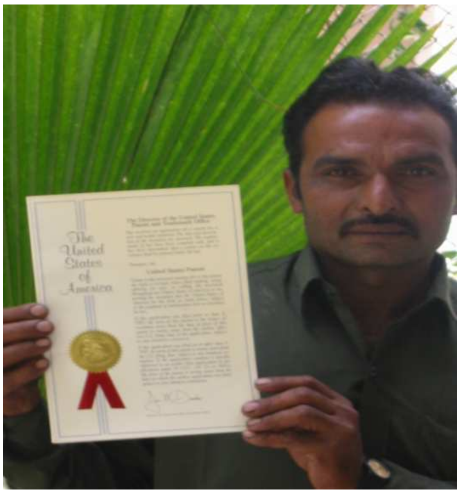
Limitations of design

- Requires high investment & Not suitable for local production
- Provision for additional requirements of farmers are missing (like provision for carrying equipments while transportation from home to farm)
- Plough needs to be redesigned, which is not acceptable by the f armers.
- Low users friendliness.

Value addition by GIAN - TePP projects (Apr 02 – Nov 04)

Crude Prototype	Improved Version
Speed Reduction by Chain Drive and no Reverse Speed Arrangement	A new gear-box with reverse gear option is incorporated and minimized the power loss due to direct shaft attached to gears
No reverse gear facility	A new gear-box with reverse gear option is incorporated

IPR Protection



India	Status-Applied for Filing Dt: 22/07/02 Aplln. No: 659/MUM/2002
USA	Status: Granted Filing Dt: Feb 22, 2002 Granting Dt: Feb15 2005 Patent No: US6854404B2

IPR infringement:

Product has been copied by few focal fabricators of the same region. Though persons who copied the design are charging lesser prices, many farmers prefers to buy it from innovator because of quality product and innovator’s is ahead in terms of value addition. He keeps improving the design by incorporating the user’s feedback

Value addition – being under taken by CMERI (CSIR Lab)

- Rear Wheel, Sprocket, chain, brake system etc NEED NOT BE REMOVED.
- Removal of the Rear Foot Rest is needed only in the modified design.
- This cuts down the time for fitting to a mere 20 minutes, even for a less trained person

Comparative benchmarking

Parameters	A pair of Bullock	Motorcycle plough (Santi)	EICHER tractor (eicher 242 di)
Technical Features			
Power (HP)	A Pair is equal to 2 HP	6.5	24
Gear Systems	No	1 – 2 – 3 & reverse	Sliding mesh gear 8 forward 2 reverse
Max. Traveling Speed	3 kmph	45 kmph	35 kmph
Availability of PTO	No	No	Yes
Availability of Hydraulics	No	Mechanical Lift	Double Cylinder 1000 kg capacity
Fuel consumption (Average)	Cost of fodder is Rs. 200 per day	0.5 lit / hr	2 lit/hr
Performance / Coverage			
Haulage capacity	500 kg	750 kg and with trolley 3 tons	4 – 5 tons
Start up time	3 hrs	15-30 mins	15-30 mins
Operations performed	Cultivation, ploughing, inter-culturing and harvesting	Cultivation , ploughing , inter-culturing and harvesting , spraying , transportation	All agricultural operation with higher speed and nonfarm operations like transportation etc
Average Area Covered / hr(for ploughing	0.75 acre	1 acre	5 acres
Limitations	• Need to maintain bullock in slack time also • it requires one full time care taker • requires rest at regular intervals • No credit facility	• Need to maintain bullock in slack time also • it requires one full time care taker • requires rest at regular intervals • No credit facility	• Not affordable by small farmers, • High operation cost • heavy weight leads to hardening of soil where it runs and its frame leads to breaking of stems and flowers • Easy and subsidized credit facility.
Capital cost (Rs.)	Rs. 15,000	Rs. 65,000(B)+Rs. 22500	Rs. 2,00,000
Maintenance & repair per year	Rs. 75,000	Rs. 1,000	Rs. 20,000

Technology Benchmarking – Operation & maintenance cost comparison

Use of Draft Animal (Two Bullocks)	Motorcycle Plough	Tractor
Productivity (labourer) = 5 hectare / day	Cost of Diesel required for 17hectare is 10 litres @ $0.5/litre = $5.00	Cost of Diesel required for 17hectare is 8 litres @ $0.50/litre = $4.00
Time taken to tilt 17 hectare = 3.5 days		
Amount spent / labourer = $ 1.25/day **Total amount = $ 4.17 /-**	Labour Requirement for 17 hectare for operating and maintenance is $ 2.50/17 hectare @ 2 labourers = $2.5x2 = $5.00	Labour Requirement for 17 hectare for operating and maintenance is $2.50/ 17 hectare @ 2 labourers = $2.5 x 2 = $5.00
Amount spent on fodder /day **= $ 2.5 / bullock** **= $8.75 ($ 2.5 x 3.5)**		
Total amount ($4.17 + $8.75) = $12.92	Total cost / 17 hectare = $ 10.00	Maint. + Over. 20% Total cost / 17 hectare = $10.90
Cost / hectare = $0.77	Cost / hectare = $0.6	Cost / hectare = $ 0.68

SWOT ANALYSIS OF THE BULLET – SANTI

Strengths	Weaknesses	Opportunities	Threats
Cost effective	Less turning radius	Potential usage among various level of farmers	Easy to copy
User friendly	Gets stuck at times in wet clay	Employment opportunities at various levels	Adoption not at larger level
Less Maintenance	Low level of the lower chain area	Revolution in agricultural sector if adopted at mass scale	New technological options
High speed sowing options	Reverse system not possible	Reduction in cost through further design	Obsolescence over a period of time
Small capacity trailer carriages	Hydraulic system not built	-	Non stake of enterprises and entrepreneurs
Variable crop inter-culturing options	Switch over time to convert motorcycle into plough	-	-

Business Development

- Global Business Plan by Sloan School of Management MIT,BOSTON (2000)
- Business Plan by IIMA – For India (2003)
- Set up production facility with financial support (US$ 3500/-) at innovators place
- Displayed in Global Auto Expo 2002 at New Delhi
- Participated in CSC 2002 conference at South Africa.
- Approach to EICHER & Atul Auto – big motorcycle manufacturing company for Technology transfer
- Organized demonstration in Maharashtra in 2004
- Awareness generation through participation in local exhibition of Gujarat (2005-06)
- Survey on diffusion study - 2007

Market Research through exhibition – Participation in global level Auto Expo

Bullet Shakthi

Autoexpo 2002

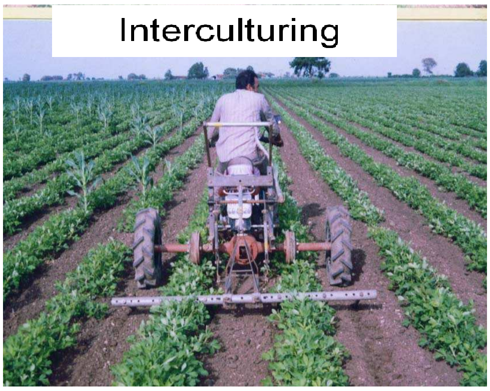
Response and suggestions from Auto expo

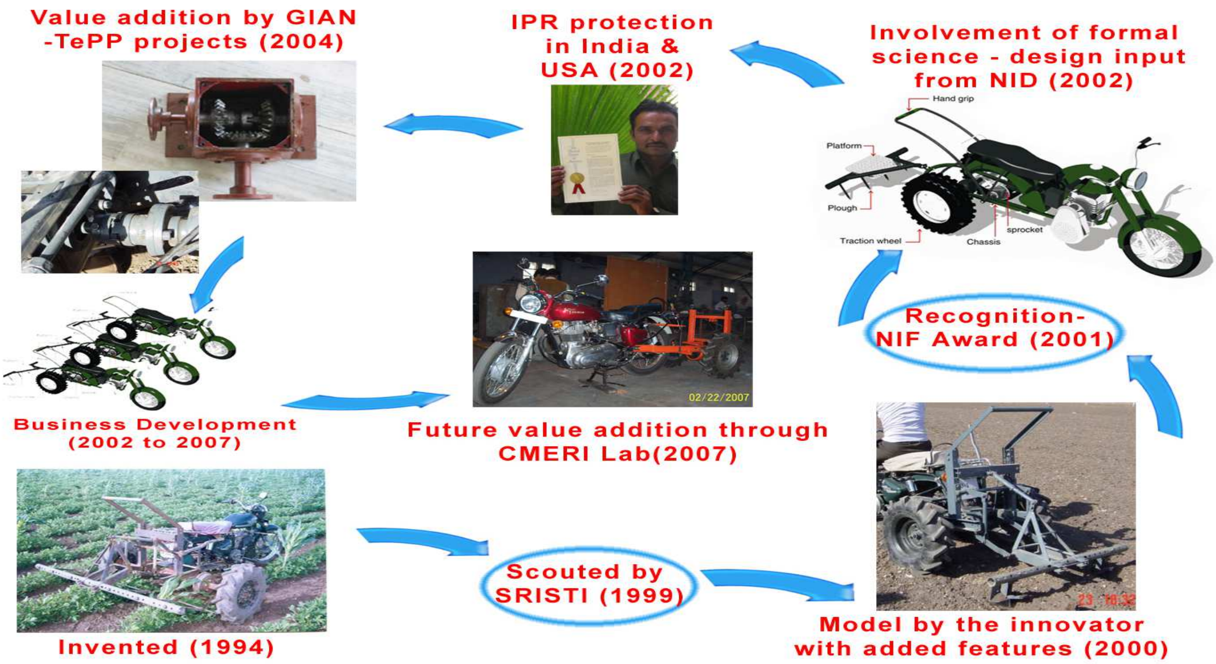
- Many suggested it can be used as load carrying vehicle on road.
- Can be used for defense purpose for higher altitudes.
- A trekking bike.
- Engine could be mounted back to avoid transmission loss.

satish komaragiri National Institute of Design 2002

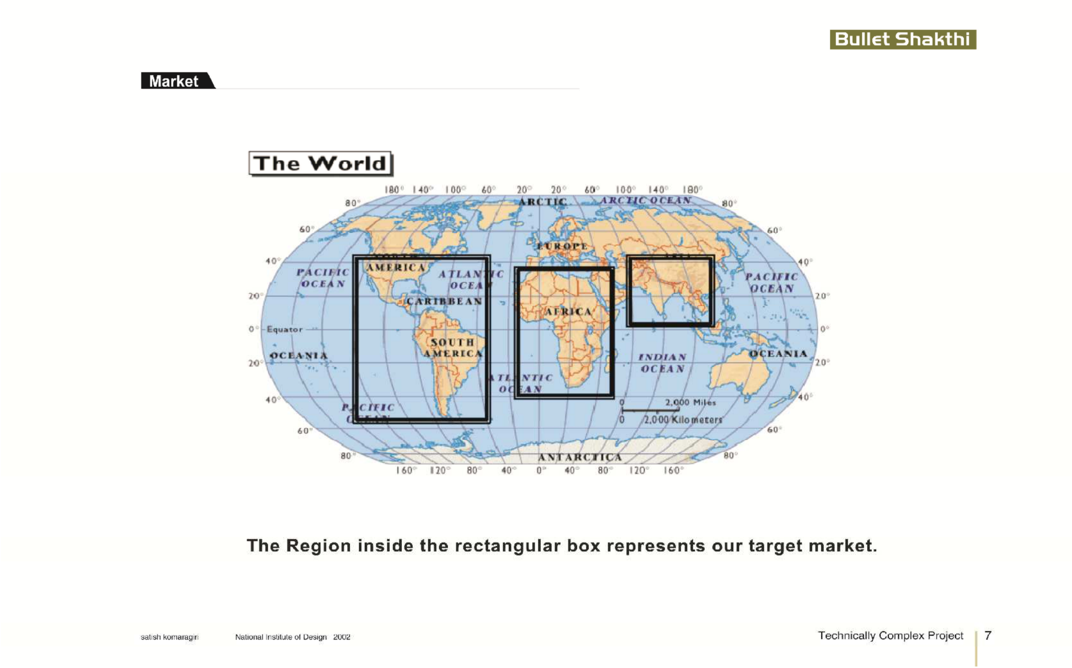
Technically Complex Project | 14

Expanding the Applications

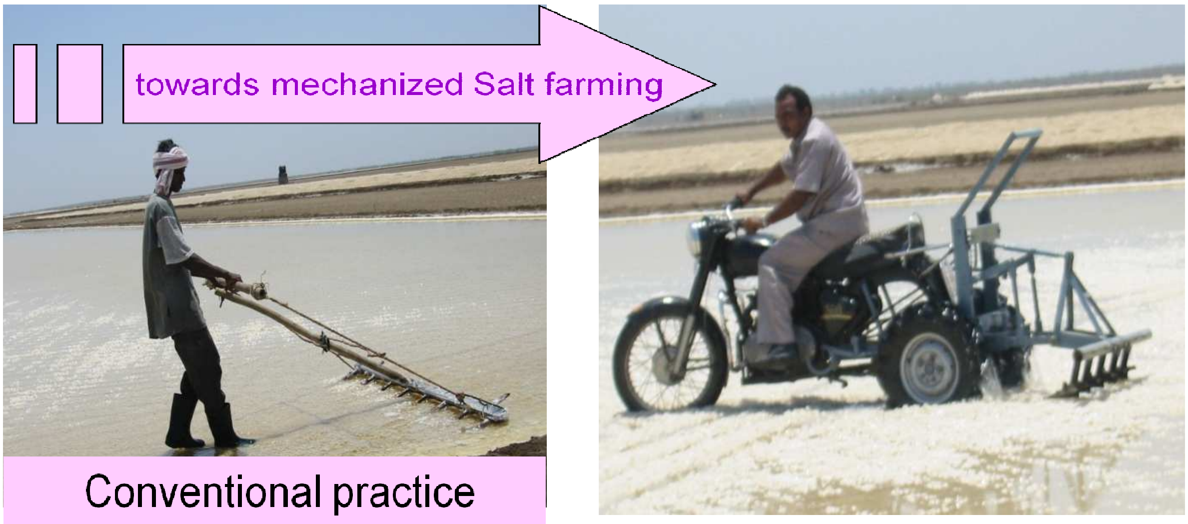




Potential market



New Business opportunities – Nonfarm applications



- Haulages purpose at airports & industries
- Grass cutting application
- Application in army

Constraints / Limitations observed in business development

- Limited entrepreneurial ability of the innovator
- Non availability of company made diesel motorcycle (having 6HP engine with 3000 rpm) restricts the market
- For big automobile company , it is a issue of diversification and scale of market
- Cost competition with small tractors if we offer it with new motorcycle
- Useful for light and sandy loam soil only
- Limited buying power of small farmers and Issues of approval from Govt Authority to avail bank loan facility
- Lack of systematic marketing efforts

Incubation Life Cycle - Timeline

Year	Particulars
1994	Prototype 1 invented by innovator
1999	Scouted by SRISTI
2000	Displayed in ISC, Pune
2000	Prototype 2 - by Innovator
2001	Recognition - NIF Award
2002	Prototype 3 - by GIAN through NID
2004	Prototype 4 - by GIAN through TePP
2002	IPR protection in India & USA
2002 – 07	Business development continue
2007…..	Prototype 5 – by GIAN through CMERI

Technology Transfer

The implement of the technology "Low cost tiller" has become quite popular in Amreli and other parts of Saurashtra region in Gujarat. Many local artisans have started manufacturing it locally by adapting Mansukhbhai's model. The innovator has the patent in his name (US patent number: 6,854,404 and Indian patent number: 205097). Since the technology had to be made "open source" in Kenya, SRISTI decided to procure the sole rights for manufacturing the machine from the innovator.

Project Outcome

The main issue in Kenyan agriculture is preparing the land (ploughing and sowing). A large proportion of the agricultural land is uncultivated and has become hard, with an outgrowth of grass. The local people are looking towards the Santi as a possible solution to this uncultivated land.

People in the target areas of Kenya cannot afford big tractors and people across the spectrum are fed up with imported technologies. Their priority is to plough the land before or after the rains for timely sowing of seeds. All other operations like inter-culturing, harrowing, bed preparation etc have a lower priority. Hence the first and foremost need is for the Santi to adapt itself to plough this uncultivated land and not to carry out shallow cultivation or harrowing as it has been used to do back in Saurashtra. As seen in the demonstrations, the Santi could be adapted successfully to operate the local plough (earlier used with power tillers) in most of the counties where these were held. However, the feedback provided by farmers, Juakalis and scientists etc. showed that more work needed to be done to make it suitable for local soil conditions.

During the demonstrations it was observed that because of uneven land, the stability of the overall body of Santi was affected, which had to be addressed. JKUAT Farm Machinery Workshop manager tried to operate the Santi in the field but he failed to control the vehicle and could not plough for more that 10-20 feet. It was suggested that a round steering could make the Santi more user-friendly. It was also felt that a four-wheeled Santi would address the issue of stability.

Fabricators and farmers of Machakos county watch intently as the new model made its first appearance.

In the last week of November 2014, the four wheeled-version of the Bullet Santi was ready for demonstration. The first point of demonstration was at Kimutwa village.

James Kitolo of Kimutwa village in Machakos County is a mechanic and a farmer. He has in principle agreed to train people in operating a tractor and is willing to host the machine at his place so that people can rent it. It was decided to put one of the tractors at his place after the demonstrations are over.

The Bullet Santi is now modified into a mini-tractor and received quite well appreciation in Kimutwa, Machakos. The villagers in the Kimutwa village are excited about the machine and thronged near the truck although the team arrived around dusk.

Racing against the time, many farmers have tried their hands on the tractor for plowing and in total approximately a quarter of an acre had been plowed.

The farmers are satisfied with the performance of the tractor and were inquiring how sooner the machines will be available for sale in their region.

The changes proposed in the bullet santi were the most critical. The most significant feedback from Kenyan farmers had been to develop a four wheeled version of the santi so as to suit the rough local terrain and make the product more user-friendly (easier to handle and more stable). To discuss this and other feedback it was decided to call a meeting of all fabricators of the Bullet Santi. This meeting was held in Rajkot on 2nd of May, 2014. During the meeting, the fabricators who are also the local artisans and innovators in their own right were unanimous in their opinion that a four wheeled version would be significantly better to handle and more suited to the Kenya terrain. This opinion was further strengthened by the realization that in a large part of the project area, women were expected to be handling the machine. In the current three-wheel version, even the men had experienced difficulty in handling it. With the specific objective of making the santi more user-friendly and stable through improved design, we organized a twenty-day workshop in June 2014. The workshop was attended by a variety of participants including santi users, innovators and fabricators on one hand and engineering students (with background in automobile and mechanical engineering) and design experts on the other. The workshop included extensive on-field trials of the original model, feedback from local users and detailed discussions with fabricators and other stakeholders in the value chain. Once the participants were aware of the context and the finer technical details of the model, they applied a design thinking approach to make frugal but significant adaptations to the machine especially the handling (maneuvering) and plowing aspects.

Meanwhile Mansukhbhai the original innovator was preoccupied designing a robust transmission system for the santi. Mansukhbhai not only added an extra wheel to the machine, but also integrated the gearbox and differential assembly. He also experimented with the PTO mechanism. These changes were intended to make the

assembly more compact and efficient at the same time.

Once the team had finished with the modifications, it tried out the tiller on the JKUAT testing farm. The results were pleasantly surprising. The plow managed an almost constant tilling depth of 8.5 inches. Six furrows were made at a time to test the machine and the results were repeatable and consistent.

Shuja (a four wheel modification of the Bullet Santi/Frugal Tiller) is on track to be reproduced in Kenya. The first prototype is likely to be ready by Mid-June, 2016. Much of the research and development for Shuja has been done. The modified tractor Shuja has been successfully developed by Numerical Machining Complex (NMC). The reduction gears are being developed and by the second week of June, the first Kenyan made tractor should roll out. After that a series of tests would follow to make sure that the tractor is performing well. By the end of July, it is expected that we will have finished the prototype testing. The entire value chain of Shuja is mapped out and a stakeholder's workshop was held on September 11, 2015 where various actors reconfirmed their commitments to be involved in the Shuja ecosystem. However, the most critical moment of truth will be when the locally assembled machines are rolled out into the Kenyan market. That they meet the expectations of quality and economy held by the local farmers would be one of the most important measures of success for the project and for that to happen, intensive trials will have to be done.