Green Looms Testing Report

SELCO Foundation

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Background & Context

The history of handspun cloth and woven fabric is embedded in the history of India. Mahatma Gandhi elevated spinning and weaving into a political metaphor for self-sufficiency and self-government. He gave wing to the Khadi Movement in the 1930s that helped reinstate dignity to the hand labour craft. Khadi has gained legendary stature as the simple fabric that defined an entire freedom struggle's ethos.

Today in India, handlooms are the second largest employment provider after agriculture, providing livelihood opportunities for approximately 4.5 million people. The ancient craft of handloom weaving is largely decentralized and most weavers are from the poor and vulnerable strata of society. There are several regions across India with weaving clusters steeped in textile traditions. Floral, mythological, geometric, abstract, animal and bird motifs are woven into the loom. These master artisans, with their unique aesthetics, imprint the cloth with color, pattern and texture. Some weaving communities are heavily integrated in the production cycle of converting yarn to fabric, including dyeing. Spinners, weavers, and all those engaged in allied activities produce 7203 million square meters of cloth per year. Fabrics are woven from cotton, silk and wool - each natural fabric spawning an industry of its own. Woven fabrics are an intricate study in warp and weft. Although the end product is a masterful craft creation, making each hand woven piece is a physically arduous process that is repetitive and unyielding.

Weavers spend laborious hours everyday to make beautifully detailed saris and shawls, moving their hand 18000 times to set over 25 kilometers of thread. Weavers are dis-incentivized to continue practicing this generations-old craft given low wages, competition from power looms and giant textile mills, imported cotton goods, increased price of yarn, and insufficient supply of quality raw cotton. The handloom census of 2009-10 revealed that almost 57 % of handloom worker households live below the poverty line. There are several initiatives and schemes set up by the government to build a supportive structure for artisans to preserve the craft of weaving. But because of the unorganized nature of the weaving clusters, government agencies often fail to direct assistance in fruitful ways. The struggle ahead is to unite the weaving industry into contemporary narratives by creating a sustainable ecosystem for weavers to thrive in.

The Problem

Extreme drudgery due to the monotonous repetitive movements

- Immense stress and strain, causing early fatigue experienced by the weaver
- Low efficiency of the hand loom coupled with the intensive physical intervention required which results in low productivity
- Lower income levels due to the low productivity factor
- A dying vocation, where the current generation is not accepting this vocation due its tedious physical involvement and proportional lower incomes. The traditional weavers are seeking alternative livelihoods as well
- The power loom having considerably higher productivity and efficiency are factors that are discouraging the use of handlooms
- However, erratic and unreliable electricity supply hampers the continuous production by power loom users

The Solution

An innovative, custom designed efficient loom that combines the motion of 4 limbs into 1, reducing the stress and strain

- Productivity increase by technological inputs
- Flexible access to mid and long term credit for affordable financing mechanism, enabling feasibility into the financial aspect of the weaving form
- An option to power the loom with a renewable efficient source of energy like solar to overcome erratic power supply
- The simple solution allows for a transformational change in the way weaving has been practiced since the Khadi movement in the 1930s.

Technical Details of the Solution

A basic understanding of loom functionality would be beneficial before the efficiency of looms is discussed. Fabric is created when horizontally and vertically threads are interwoven with each other. The easiest way to do this is to fix a set of vertical threads and move horizontal threads up and down alternately between them. These vertical threads are called warps and horizontal threads wefts.

Now, instead of moving the weft up and down between the warps, it is even easier if alternate warp threads are lifted up and the weft thread is simply moved across horizontally. This simple principle is used in all looms. The warp is usually first fixed and set in the loom through a reed which helps keep each warp in its place. Then the above mentioned interweaving is achieved through 3 different operations in a handloom - **Shedding, Picking and Beating.**

SHEDDING

In weaving, the shed is the temporary separation between upper and lower warp yarns through which the weft is woven. The shed is created to make it easy to interlace the weft into the warp and thus create woven fabric. The term shedding refers to the action of creating a shed.

PICKING

As the harnesses raise the heddles or healds, which raise the warp yarns, the shed is created. The filling yarn is inserted through the shed by a small carrier device called a shuttle. The shuttle is normally pointed at each end to allow passage through the shed.

In a traditional shuttle loom, the filling yarn is wound onto a quill, which in turn is mounted in the shuttle. The filling yarn emerges through a hole in the shuttle as it moves across the loom. A single crossing of the shuttle from one side of the loom to the other is known as a pick. As the shuttle moves back and forth across the shed, it weaves an edge, or selvage, on each side of the fabric to prevent the fabric from raveling.

BEATING

The beat-up mechanism beats or pushes the newly inserted length of weft thread (pick) into the already woven fabric at a point known as â€œfell of the clothâ€. These three mechanisms namely shedding, picking and then beat-up are done in sequence.

Besides these, there are many other settings that are necessary to weave successfully, such as Warp Tension, Picks per inch and End per inch settings.

In the processes mentioned above, the energy demanding processes are shedding, picking, beating, rolling back of beaten wefts and tension control of warps. In a handloom, the speed at which a weaver co-ordinates pedaling and hand movements determines the productivity whereas in a powerloom, the speed at which a drive can safely carry out the motions without breaking the threads determines productivity. Productivity can be increased by increasing efficiency, better automated controls for the coordination between different actions required, lower the time required for movements.


RLP
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The Efficient Green Loom, looks at increasing the efficiency and automating the coordination movements, to improve the regular handloom into a more productive handloom. This is achieved by automating all the coordinated movements through a single movement and by reducing friction together by which even a lower skilled weaver can weave quite fast with just one hand (as against pedaling and two hand motions in regular looms). The Efficient Loom also provides option to automate this one motion required into a motorized action thereby converting the entire handloom into a powerloom, completely provisioned to be powered by Solar.

LAB TESTING

After thorough market research, a loom manufacturer was identified - NRG Solutions. This manufacturer had already deployed many looms in the market across India and it was tested and lab testing data was available. NRG Solutions primarily worked with cotton mill yarn (90%) and the rest with silk yarn. Their looms were present with weavers in Bikaner in Rajasthan, Manipur etc. They had never tested their loom with khadi before their stint with SELCO Foundation.

Hence, a lab testing process just to verify the claims was conducted and it was subsequently taken to the field testing stage.

Field Testing

Site #1: Belgaum Loom Testing

The Belgaum loom site has an individual weaver named Nazir Ahmed Kamal who used regular frame looms for his weaving activities. He received market support by Milan Handicrafts.

The yarn here used is a cotton mill spun yarn, which is twisted hence there was no problem of sourcing the yarn, but since this being the first field test for the loom, there were several problems in speed of the loom itself which affected even the mill spun yarn. Hence test was carried out with same count of yarn, with different speeds to see which speed best suites the weaving resulting in highest productivity.

TECHNICAL SPECIFICATIONS

Motor: 700 watt DC motor

Consumption : 150 Watt

Solar system: 8 hour backup

CAPACITY

8 to 10 meters a day

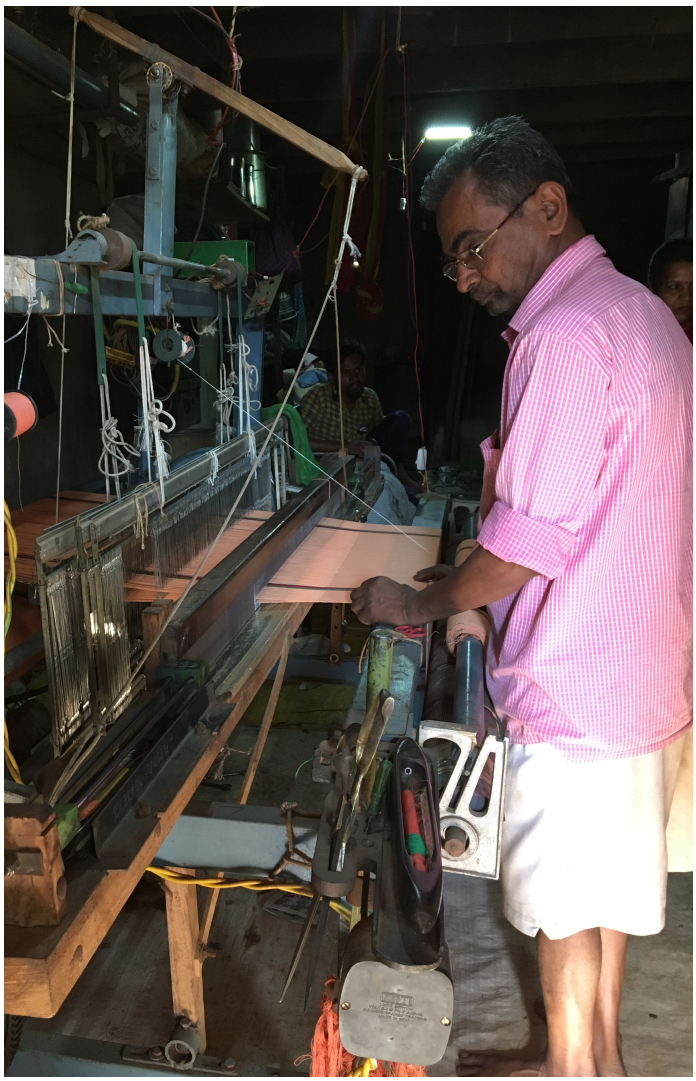
Max 45 inch width fabric

MAX 60 meter length fabric

Cost: 45,000 loom cost, 70,000 solar system cost

TEST RESULTS

- In the beginning of the test, the weaver would produce up to 3.5 meters of fabric with a peak of 28
- The count of yarn tested is cotton which was a 20/2 english count dyed yarn.
- For the second test, the period peak increased to 40 inches, with a ppm (picks per minute) of 60.
- By the end of second test period, the production went up to a maximum of 14 meters of fabric with an average of 12 meters a day



Comparative table of Nazir's productivity and earnings:

Weaver using Handloom

Description	**Quantity/Amount**
Daily Production - Meters	8
Earning per meter (Weaver)	INR 30
Daily Earning per Weaver per day	INR 240
Monthly Earning of the Weaver	INR 5760

Weaver using Efficient Loom Powered by Solar

Description	**Quantity/Amount**
Daily Production - Meters	15
Earning per meter (Weaver)	INR 30
Daily Earning per Weaver per day	INR 450
Monthly Earning of the Weaver	INR 10,800

Increased Productivity and Earnings

Description	**Quantity/Amount**
Daily Production - Meters	15
Earning per meter (Weaver)	INR 30
Daily Earning per Weaver per day	INR 450
Monthly Earning of the Weaver	INR 10,800

Field Testing

Site #2: Coimbatore Loom Testing

The Coimbatore loom site i.e. the Avarampalyam Sarvodaya Sangha is a Khadi board approved weaving center.

DEMOGRAPHY

There is a lot of weaving practiced around Coimbatore, which is why this Sangha was decided to be set up there in order to provide market linkages for these weavers. Both cotton khadi and silk khadi is weaved in this centre but there is more prominence given to silk. The processing units for silk are placed here as well along with the cotton processing. A few weavers are involved in processing the silk and a few in the making of the fabric.

Since it is a khadi center, the yarn which is used to weave is spun using an Ambar Charkha which is not twisted. An Ambar Charkha or floor charkha is one of the oldest known forms of the spinning wheel. The charkha works similarly to the great wheel, with a drive wheel being turned by hand, while the yarn is spun off the tip of the spindle. The untwisted yarn produced from it is more susceptible for breakage if more force is applied.

The installed solar loom running on 700 watt DC motor, due to a charge variation results in some change in the speed of the motor which in turn affects the force of the beater. Hence, the different count of cotton khadi yarn was tested to see which count could withstand little variation in speed and which ones couldn't

In the next iteration, a little variation in the control panel was made to overcome the problem of yarn breakage in case of khadi yarn with the help of the manufacturer and a different type of yarn was tested including, linen khadi yarn.

Avarampalyam Sarvodaya Sangha was keen to try out the linen khadi of count 60 on the solar loom, since they wanted to introduce it to their customers. The linen khadi which they wanted to bring into the market, they specifically wanted it to be solar powered so that they could introduce solar into their existing energy systems and processes.

TECHNICAL SPECIFICATIONS

Motor: 700 watt DC motor

Consumption : 150 Watt

Solar system: 8 hour backup

CAPACITY

15 meters a day

Max 45 inch width fabric

MAX 60 meter length fabric

Cost: 45,000 loom cost, 70,000 solar system cost

TEST RESULTS

- Cotton khadi yarn of count 20, 35 and 55 was tested
- Cotton khadi yarn with a khadi count of anything more than 35 was very difficult to weave by the weaver who was new to this loom
- Cotton khadi yarn with khadi count of 55 was hard to weave even for the well trained weaver
- Linen khadi yarn of count 60 was tested and only a highly skilled and experienced weaver was able to manage to weave.

ISSUES FACED

A speed variation issue was found in the loom which was also recurring in the looms that NRG had installed in sites across India before SELCO. It was not an issue for those NRG sites as they were not khadi centers. However, it was an issue here because the yarn which was used here was khadi yarn and not mill spun yarn. Mill spun yarn is a twisted yarn i.e. it is stronger, whereas the khadi yarn is untwisted (spun in ambar charkha) which is relatively weaker and prone to breakage due to any change in speed.

A solution was co-developed with NRG and SELCO Foundation where a new control panel was made with a solar charge regulator to minimize the speed variation of the motor. Variation in the speed of the motor will in turn affect the force that is applied on the beater which would cause the yarn to break.

Modification to the Looms

Post field testing and evaluation, some modifications were made to this particular loom and some to the product on a whole before it could be taken to a pilot stage:

1. A trammel is a clutching device that is on the loom to hold the cloth firmly while weaving. The trammel also helps align the seams of the fabric. In the original design, there was no trammel included in the loom. Post field testing, a trammel was retrofitted through a local fabricator for this particular loom. Trammels were bought with fixtures and they were fixed on to the loom in this site.

2. A dead weight fixture was not given by the manufacturer. For the warp yarn to be straight, a tension weight or dead weight is installed onto the beam. In hand looms they generally tie it with a rope (like break drum). Here, the site requested to have a fixture for putting the dead weight on the loom. Hence, this was procured from fabricators and retrofitted onto the model.

3. The loom used to come with a standard design of V-belt and V-belt pulleys. It is a V shaped pulley and belt when looked through the cross section. But it was changed to a flat belt and flat pulley (leather) in accordance of the speed control problem. A flat belt will have less friction and no slippage as opposed to the V belt. This helped with the speed control problem.

4. The peak of the machine was increased from 40 to 60. Because the cloth was required to be smoother and more compact i.e. the number of threads per inch (peak) to be more. The original design was changed to increase the peak from 40 to 60. As a result of this, the pick changed as well. This results in decrease of production but the centre wanted an increase in quality of the fabric. This is optional for weavers and centres that are willing to compromise on quantity for quality.

5. The reed was fitting onto the frame on two pivot points with small bearings earlier. Now it has been replaced with an entire shaft with bigger bearings. The two points will now be on the shaft. As the weight has been distributed from the points to the shaft, the loom functioning has become much smoother.

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