Chapter 2
Improved Technologies Under the Rural Technology Action Group (RuTAG) at IIT Delhi

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1 Introduction

Rural Technology Action Group (RuTAG), a mechanism to develop and disseminate technologies for rural areas was initiated by the Office of the Principal Scientific Adviser (PSA) to the Govt. of India. The coordination of RuTAG activities was assigned to seven IITs at (a) Madras, (b) Guwahati, (c) Kharagpur, (d) Roorkee, (e) Delhi, (f) Mumbai and (g) Kanpur. IIT Delhi was assigned to coordinate the activities in the states of Madhya Pradesh (including Chhattisgarh), Rajasthan, Haryana and Delhi. The idea is to identify the technology needs of the region, available technology solutions, and problems encountered in adopting the existing technology at the grassroots. It is also the mandate of the RuTAG units to identify the R&D institutions which can improve the technology to suit the local conditions and assessment of the existing technology by relevant R&D activities with reference to the problems identified. RuTAG units find solutions not only to overcome the technological problems but also to make them adaptable to local resources and production coordination.

RuTAG Club is an initiative taken by RuTAG IIT Delhi to develop an interest in students of IIT Delhi for the rural technologies. In this regard, several orientation

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sessions were organized to boost student participation and create awareness. Many academic projects were undertaken by the students, and some of their works were also published. There are monthly meetings to discuss the progress of various projects, their execution and other activities to be taken up by the RuTAG club members. The club aims to achieve a state where students can apply their knowledge and contribute to their nation with fun and joy. All such activities are reported in half-yearly newsletters which include activities from other RuTAG centres as well.

2 Rural Technology in IIT Delhi

Rural Technology has been one of the major areas of research in IIT Delhi for a long time now. In 1978, Centre for Rural Development and Technology (CRDT) was established. It facilitates in carrying out research focused on areas such as Rural Energy Systems, Biomass utilization and appropriate technologies for artisans.

In 2000, mechanical designs of improved looms, cleaning machines, drying chambers, etc. for the hand-knotted carpets were done by CRDT in collaboration with the Department of Mechanical Engineering [1, 2]. They were successfully demonstrated in Bhadohi, Mirzapur in Uttar Pradesh, and Srinagar and other places of Jammu and Kashmir. Later in 2001, IIT Delhi collaborated for a project with Khadi and Village Industries Commission (KVIC) [3, 4]. As a result, Mahatma Gandhi Institute of Rural Industrialization (MGIRI) was established at Wardha, Maharashtra.

Rural Technology Action Group (RuTAG) at IIT Delhi was established in 2009 after the successful establishment (2004) and stable function of the same at IIT Madras by the office of the Principal Scientific Adviser (PSA) to the Government of India. RuTAG provides Science and Technology (S&T) inputs to reduce technology gaps existing in the rural sectors [5, 6]. The technological requirement should be demand-driven, and must interface between the rural majority and an institution of excellence like IITs through S&T oriented voluntary organizations working in the area of technology under consideration. These organizations are generally familiar with the local people and their environments. This makes the change over to the improved technologies smoother.

3 RuTAG Technologies at IIT Delhi

Since 2009, RuTAG IIT Delhi has been involved in many projects, with a duration of six months to two years. Out of these, the following projects had a significant impact on the livelihood of rural people.

3.1 *Improved Device for Making Beads from Holy Basil (Tulasi)*

In the villages near Bharatpur, Rajasthan, beads are made from the stems of Holy Basil (Tulasi). These are consumed to make garlands for the temples of nearby areas. Artisans have devised their own conventional arrangements (Fig. 1) for turning, drilling, polishing and cutting beads from the stem of Holy Basil. The process is cumbersome, and the productivity is low. The quality is also inconsistent. Around 400 women are engaged in making these beads for their livelihood [7]. An improved device for making the beads was developed at RuTAG IIT Delhi which is shown in Fig. 2. It was earlier reported in the reference [1]. The artisans are happily working on the improved device. It allowed artisans to work for longer durations (upto 12 h a day compared to 7 h earlier). Hence, one earns about Rs. 1200–1400 per day (compared to about Rs. 400 per day). The cost of the improved device is about Rs. 5000 compared to about Rs. 1500 for the existing device which has the following problems:

- It comprised of five components namely, motor, stem holder, battery, cutting tool and needle supported on the fixed tailstock.
- The motor is held in hand continuously to perform turning, drilling, polishing and cutting of each bead throughout the day. These caused pain in the arm, neck and back.
- Irritation and pain in the arm and fingers when the motor was stopped by bare fingers to remove the finished bead periodically from the needle.
- Motor ran only on battery.

Fig. 1 Existing device

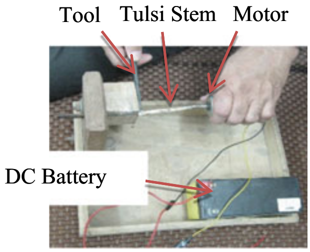
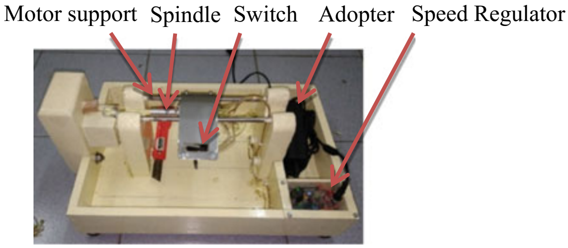


Fig. 2 Improved device



The improved device conceived by RuTAG IIT Delhi, as shown in Fig. 2, incorporated the following features:

- A support was provided for the motor without the need to be carried by hand (Fig. 2). The motor can slide over it.
- A switch was provided to stop the motor, instead of stopping it manually with the fingers.
- An adapter was provided to run the motor using electricity instead of the battery which needed to be charged at regular intervals, thus, causing inconveniences in the middle of work.
- A new stem holder with proper alignment and the self-locking feature was introduced which reduced vibration in the device.
- A contactless switch based on infrared (IR) sensor is under development due to the shorter life span of the manual switches.

Based on the intervention by RuTAG IIT Delhi, the following inputs were observed or reported:

- Better sitting posture resulting in reduced pain in neck and back.
- Consistent finish of the beads.
- No need of battery and its recharging, thus, avoiding inconveniences.
- Enhanced productivity and income (Fig. 3).

So far more than 100 devices were sold by the manufacturers in Bharatpur and Ghaziabad. The development of the device was reported in the international conference of the Indo-Dutch [7] and later published in the journal 'Current Science' [8]. RuTAG IIT Delhi exhibited the same at the International Conference on Robotics and Automation for Humanitarian Applications (RAHA) 2016 in Amritapuri, Kerala based on which the AMMACHI Lab adopted the same livelihood generation of the women in Vrindavan, Uttar Pradesh [9].

Fig. 3 Improved productivity of women livelihood

3.2 Improved Design for Treadle Pumps

A treadle pump is a mechanical device which used to draw water from the ground using human power. It consists of two cylinders. Water is drawn due to the reciprocating actions of the pistons. The pump is predominantly used in parts of Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, West Bengal and Karnataka. This is suitable to use in places where the water level is not below 7–10 m. The pump was improved by RuTAG IIT Delhi from two perspectives. The first one is shown in (Fig. 5) which is mainly based on ergonomics, and the use of better quality material for the washers in the cylinders. Later, to reduce the cost of the pump and to ease assembly operation by the rural people, locally available plumbing and the parts of hand pumps were used, as shown in Fig. 6.

The problems which existed in the treadle pump (Fig. 4) are highlighted below:

- Cylinder was made using mild steel sheets, therefore, cylindricity was poor.
- Pedals were fixed on lever.
- No hand support for the operator while treadling. They hold branches of a tree, if available.
- Stress on knee and calf muscles due to inappropriate lever length.
- Rapid wear of piston washers.

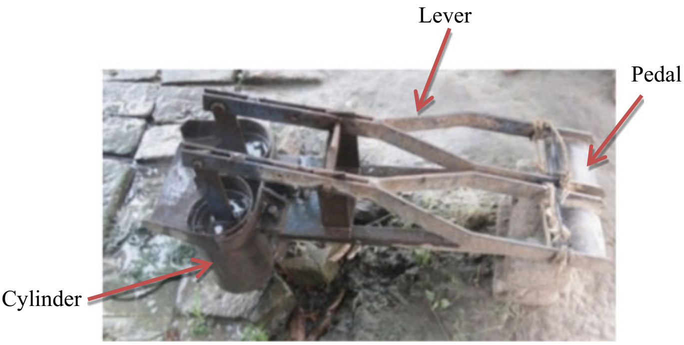


Fig. 4 Existing treadle tump

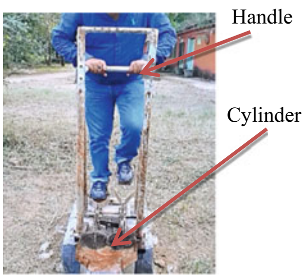


Fig. 5 Improved treadle pump

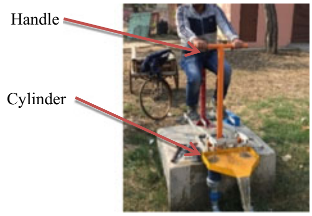


Fig. 6 Improved treadle pump using locally available parts

The salient features of the improved treadle pump (Figs. 5 or 6) are listed below:

- Use of standardized components.
- Cylinders were made using steel pipe to maintain cylindricity.
- Rocking wooden pedals (like in bicycle) were provided to reduce stress on knees.
- Handle was provided for support while treadling.
- Location of the pedals on lever can be adjusted according to the weight and height of an operator.
- Washers were made using NBR rubber to increase their lives.

The impact of the intervention can be summarized as:

- Eleven treadle pumps were installed in Orissa, Uttar Pradesh, Bihar, Madhya Pradesh, Karnataka and West Bengal.
- Reduced drudgery in operation.
- An operator can operate for longer duration.
- Water discharge rate of improved Treadle Pump is about 3500–4000 litre per hour compared about 2500–3000 litre per hour for the existing Treadle Pump.
- Cost of improved Treadle Pump is about Rs. 10,000 compared to Rs. 5000 for the existing Treadle Pump for the projected life of about 10–15 years.

The improved device was also reported in [3]. Recently, two sets were installed in Prasia near Bhopal and Balaghat, Madhya Pradesh for further use by the people around those two places and adaptation by them. Besides, a multinational company showed interest in installing the same in a city park where people come to exercise. The pump could than water the flower, plants, etc.

3.3 Animal Driven Gear Box for Multiple Rural Applications

The use of animals for farming has been very ancient. However, the technologies for harnessing animal energy have remained at a primitive level for a very long time. As a consequence, with the advent of fossil fuels, the use of animals was greatly reduced. Nevertheless, from all considerations, animals have proved to be a renewable, sustainable and holistic source of energy. Therefore, RuTAG IIT Delhi took an initiative to standardize the Animal Driven Gear Box (ADGB) (Fig. 7) and its power transmission system developed by M/s. Panchal Pumps & Systems, Kanpur. Further, the gearbox was coupled with multiple applications such as a Screw Pump, Atta-Chakki (Fig. 8), Chaff-Cutter (Fig. 9a) and Paddy Thresher (Fig. 9b). The technology was very much appreciated by small farmers who use bullocks for farming.

Problems in the existing ADGB were as follows:

- It was not standardized.
- Gearbox was big and heavy.
- Excessive load on bullocks due to the absence of lever support.
- Gearbox was expensive.
- Frequent disengagements of the gears.

After improvement, the following changes were observed:

Fig. 7 ADGB with a screw pump

Fig. 8 Power transmission for Atta-chakki

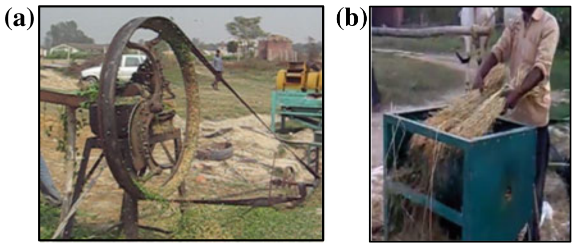


Fig. 9 Testing of ADGB with **a** chaff-cutter, and **b** paddy thresher

- Smaller and lighter.
- Reduced cost.
- Standardized design of the gear box. One can create new specifications using the well-documented steps.
- Lever support (Fig. 7) eased the burden on bullocks.
- Tested satisfactorily as Chaff-Cutter, Atta-Chakki and Paddy Thresher (Fig. 9) other than the one in Fig. 7 as a pump.

Impact of the technology so far is the reduced cost (approx. Rs. 45,000–50,000, which 10–15% less than the present gear box). So far, more than 40 such gearboxes have been sold. Other benefits that can be drawn from such technology are:

- Environment-friendliness.
- Multiple applications.

The costs of the gadgets for multiple applications are: Screw Pump Rs. 45,000; Power Transmission System Rs. 22,000; Chaff-Cutter Rs. 14,000; Atta-Chakki Rs. 14,000; Paddy Thresher Rs. 8000. One needs to add the cost of ADPM and labour cost for a single application.

3.4 Bullock Driven Tractor (BDT)

Employing bullocks for agricultural purposes is a traditional and very conventional method in India's rural areas. Tractors are, however, used these days to improve efficiency. They are costly and may not be very suitable for small landholding. Some innovative farmers wanted to blend the two ideas to come up with, say, Bullock-Driven Tractor (BDT), as shown in Fig. 10. Rural Technology Action Group (RuTAG) at IIT Delhi took up the initiative of finding the best BDT through an NGO (Social Centre for Rural Initiative and Advancement or SCRIA, Khori, Rewari, Haryana).

The 'Brahmpuri' model was found to be the one which could be pursued further. Its shortcomings were identified as follows:

Fig. 10 Existing bullock driven tractor ('Brahmpuri' Model)

- No mechanism for lifting the attachment while turning. Thus, an extra person was required.
- It was heavy.

After several levels of design improvements and field trials, the following features could be implemented in the improved BDT.

- Comfort to the tiller.
- Rope and Winch mechanism to lift the attachment (Fig. 11).
- Comfortable seat of the tiller.

Each BDT costs about Rs. 25,000 by a manufacturer in Bulandshahr (U.P.). Two sets were sent to Prasia (near Bhopal) and Balaghat, Madhya Pradesh for utilization by the farmers of nearby villages, and further adaptation of the same.

3.5 Groundwater Level Measuring Device

Groundwater is an important natural resource to meet the water requirement of many rural/urban population. Hence, reliable estimation of it is the need of the hour. Commercially available devices to measure the levels of groundwater are expensive. However, an attempt was made to develop a local probe whose two electrodes having open ends were attached to electric wiring. A battery and a beeper were put in the circuit. When electrodes encounter conductive fluid, the circuit gets completed and buzzing starts. The depth was measured from the marked cable.

The device shown in Fig. 12 is made of plastic pipe, wood, plastic reel, etc. It has the following drawbacks:

- Inaccuracy in measuring the depth of groundwater.
- Gets affected by the presence of moisture in the well, which eventually gives false reading.

Fig. 11 Improved bullock driven tractor

- Low-quality cord tears in tension.
- Due to its improper shape, the device is often struck inside well.
- Plastic reel lacks the robustness to hold probe and circuit.

After studying the existing device, an improved version was developed (Fig. 13) with the following features:

- Complies with IS 15896:2011.
- Probe is made with Stainless steel, rust-resistant material.
- Probe is an assemblage of four parts, i.e. Plumb bob, perforated tubular body, high-pressure cord holding gland, and a sensor.
- One end of the probe is a plumb bob for vertical stability, and the other end is for holding electric cord through a leakproof gland.
- Improved operational stability using plumb bob as added mass.
- Better quality cord for high tension load capacity.
- Lightweight aluminium cast cable spool with better operational life.

The probe and the improved stand with cable (Fig. 14) could impact the following:

- Rationing of groundwater for irrigation purposes.
- Management of groundwater through a network of observations of groundwater.

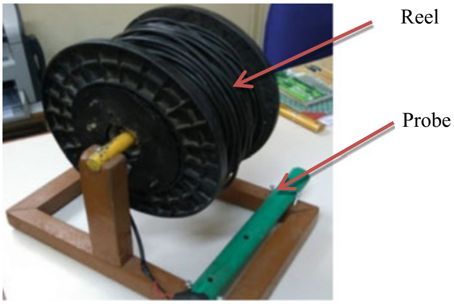


Fig. 12 Existing device for the measurement of groundwater level

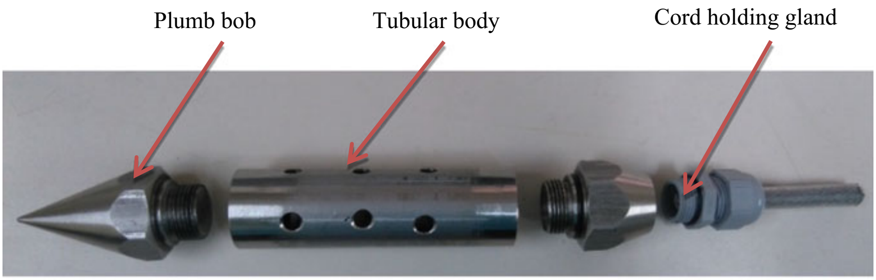


Fig. 13 Improved probe

- The cost of the improved device is about Rs. 10,000 and was tested successfully in several wells in Chirawa, Rajasthan.
- In comparison with the earlier device (priced at about Rs. 4500 with a life of about 1–2 years), the newly developed device is more robust and expectedly has longer life (8–10 years).

3.6 Indigenous Device for Sheep Hair Shearing

Currently, in most of the places across India, shepherds use scissors (Fig. 15) to cut woollen fleece of sheep. The scissors need to be sharpened at regular intervals. The manual method has problems associated with its sharpness, grip and pain to the person's hand after long use. The time required for shearing with scissors is about 30 min per sheep. The mechanized device (Fig. 16) reduced the shearing time to 4–5 min only per sheep. While such devices were imported for about Rs. 1.50 lakh per set, the objective of this project was to develop indigenous one with reduced cost.

The need for a mechanized way of shearing sheep hair is convenience and good quality fibres. The features and impact of the technology are:

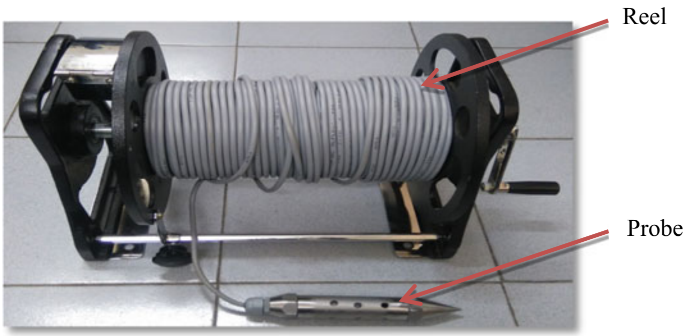


Fig. 14 Improved stand with cable and probe

Fig. 15 Manual shearing by hand scissors

Fig. 16 Indigenous handpiece

- Indigenized device at affordable cost to the shepherds.
- Easily available spare parts in India.
- Easy access to aftersales and services.
- Reduction in shearing time.
- Reduced effort and drudgery for the shearer due to mechanized operation.
- Boost to MAKE-IN-INDIA slogan.
- Employment generation through the use of the device, maintenance and manufacturing.
- Saving foreign currency.
- Possibility of export by the Indian manufacturers.

3.7 Improvement of Furnace for Bangles

Jointless bangles have significant importance in various parts of Rajasthan. Making them is the traditional occupation for the majority of families there. Artisans work in front of the furnace (Fig. 17) with a high temperature for long hours. Inefficient fuel combustion in those furnaces not only increases fuel consumption, but the smoke from it also causes health hazards. Besides, uncomfortable working posture reduces the productivity. RuTAG IIT Delhi undertook the task to improve the furnace, sitting arrangement, and associated problems. The furnace was redesigned for higher efficiency and reduction in smoke (Fig. 18). To improve seat, a foldable flexible ground chairs was provided to the artisans considering their ergonomics of operation. Improvement in the tools was also made to reduce the discomfort while making the bangles.

Note the following features in the improved furnace designed by RuTAG IIT Delhi:

- Main structure is made of earthenware (as in 'Tandoor').
- Industrial insulation (Alumina blanket) was put on both sides of earthenware.
- Structural integrity was incorporated using metallic casing.
- Floor was made of Alumina board.
- Chimney, baffle and damper were added to control the draft.

Fig. 17 Traditional furnace used for making bangles

Fig. 18 A test was conducted at IIT Delhi

- In addition, chairs were ergonomically designed to provide back support and cushioning while sitting on the ground.
- The Kalbhoot (traditional bangles sizing tool) was made with ball bearings to reduce rotational friction.

Tests were conducted with artisans from Bharatpur at Micro Model Lab of IIT Delhi. A substantial decrease in fuel consumption (65%), pollution level, and heat exposure around the furnace were recorded. The developed furnace was shifted to Bharatpur for field test and feedback. The cost of the furnace is estimated around Rs. 1.00 lakh.

4 Conclusions

It has been observed that lab-based technologies often perform poorly in the actual field. This means that the user is not benefited by the developed technology. To overcome this hurdle, technical institutes need to synergize with voluntary organizations who have grassroot level outreach and presence. This collaboration bridges the gap between rural communities and premier technical institutes. The challenge of taking into account the concerns of various stakeholders such as local administration, governing bodies and manufacturers will be easier to address. Through the seven projects discussed in this paper, it is demonstrated how a program such as RuTAG can have an impact on the livelihood of rural communities. It can be observed that RuTAG has managed to create a synergy between voluntary organizations and technical institutes. It can also be seen how the inputs from NGOs and faculty experts of the institutes can lead to impactful technical interventions that can be implemented at the ground level.

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