Artisanal Blacksmithy

Problem/Need

The rural economy in India is based on agricultural production and agro-processing, mostly in tiny scale or domestic units. Despite recent trends of increasing concentration of land holdings, a substantial majority of agricultural production still emanates from small and medium land holdings. In this scenario, a sizeable proportion of equipment used in agriculture, including minor forestry, horticulture and kitchen/homestead-gardens, continue to be based on animal and human power; and a variety of hand tools such as axes, spades, sickles, etc. continue to be a mainstay of rural economy. This is especially so when one includes the hand-tools used by different categories of artisans such as masons and cobblers.

No doubt considerable inroads have been made by recent trends towards mechanization of agriculture, and use of industrially manufactures tools such as planes, saws, chisels and so on by artisans. Yet there are constraints to the adoption and widespread use of agricultural machines due to shortage of electricity/diesel for energy apart from costs and scale of operations. Importantly, at least in the case of agricultural implements, preferred designs to farmers appear to vary considerably from region to region, making it difficult for mass manufactures tools to penetrate all areas equally.

This overall situation has thus contributed to artisanal blacksmithy being one of the few traditional artisanal trades to continue to survive in the rural economy, although its survival is at a low level of productivity and incomes, and is facing the usual threats due to rival industrial products. This continuing survival of artisanal blacksmithy, especially as compared to other artisanal trades such a Tanning or Pottery is due to the very nature of the products and services offered by this trade, and to its intimate linkages with agriculture. The variations of designs of agricultural implements due to variations in soil conditions, cropping patterns and local customs is an additional factor favouring the local artisan over mass-manufacturers.

Nevertheless, the artisanal blacksmith suffers from broadly the same kind of deprivations as other categories of “engineering artisans” such as potters, leather workers, cobblers, etc. The market for their products/services is shrinking, productivity in household modes of production continues to be low, quality of products made is poor compared to industrial products, and costs of various inputs especially fuel are rising while the mostly poor clientele are reluctant to pay higher prices.

Approach/Strategy

Detailed field investigations and analysis of 5 key implements (sickles, chisel, kudali, axe and ploughshare) made by blacksmiths in the different field locations and techno-economic analysis of the production processes brought out the following problems:

- Blacksmith’s products suffered from several technical deficiencies such as low strength and hardness, less life compared with industrial products;
- Raw materials used by blacksmiths were non-standard materials (usually scrap) thus denying them control over carbon content and other parameters governing quality of finished product;
- Processes used were limited to hand-forging (hammer being wielded mainly by an able-bodied family member) and (mostly) water quenching, limiting both efficiency of process and quality of products;
- Use of open-hearth furnaces, mostly fanned by bellows or hand-operated blowers, resulted in considerable inefficiencies, cost penalties, and inadequate temperature control.

A new/improved technology package for blacksmiths, which addresses the above problems, has been evolved by CTD (in collaboration with NML, Jamshedpur).

Technology Package

It comprises two broad components:

New knowledge or upgraded skills: To be transferred through, training, documentation and productionization along with some essential equipment. These comprise of:

- Product-specific heat treatment schedules/protocols with different methods such as annealing, oil quenching, tempering, etc.
- Surface hardening process
- Capability to assess raw material so as to make possible allowances for, or improvements to, base parameters such as carbon content.
- Capability to assess quality of finished product through critical parameters such as carbon content, hardness, etc.
- New technique for “backyard steel-making”
- Technique for Pyrolisis of waste biomass

Newly Developed Equipment:

- Fuel-efficient furnace with electric/diesel-operated blower and temperature indicators.
- Mechanical hammer (electrically driven with manual option)
- Small “laboratory” for testing hardness, etc.
- Pyrolyser

Technology Details

The **Mechanical Hammer** was developed to tackle a major problem of artisanal Blacksmiths. A great deal of unnecessary and unremunerated drudgery is involved in a member of the blacksmith’s family simply wielding the hammer and occasionally turning the blower handle. In most families this is done an able bodied person whose labour would have been far better compensated even by manual labour elsewhere. The Mechanical Hammer is designed to deliver equivalent force by a foot-pedal operating a lever-based mechanism, thus enabling the Blacksmith to use both his hands as before while freeing his family member to do other tasks as required. Needless to say, it would also improve productivity and reduce energy use by reducing the number of times the job is re-heated. The Hammer is easy to operate and costs only about Rs. 15,000 with considerable reduction of costs possible with volume production. A cam-operated Hammer also being developed.

The new **Furnace**, capable of higher fuel efficiency and better temperature control, was felt to be a pressing need from the very outset, since the low thermal efficiencies of open-hearth furnaces are well known and the increasing fuel costs being faced by the Blacksmiths are a major reason for poor viability. The new Furnace has a hooded chamber with a flue, and includes thermocouples for temperature measurement. It can be made with locally available materials and costs only about Rs. 6,000/-.

It is proposed, at a later stage, to take up **Drop-forging** at the Nodal level. From standardized raw material ingots, the forge would make blanks of products such as sickles, trowels, etc. using dies made for this purpose as per local implement designs. The blanks would be supplied to individual Blacksmiths who would thus have a high-strength high-quality blank (instead of non-standard scrap-based raw materials), which they would finish through hand forging.

The **Backyard Steel-making** is an interesting innovation adapted from the process used in the railways to mend damaged tracks. The idea to adopt such a technique in artisanal Blacksmithy operations arose from the use of non-standard, mostly scrap, low-carbon materials resulting in low-quality products. The technique is an adaptation of the alumino-thermic process in which waste oxides of iron, as obtained from steel mills and other industry sources are ignited with aluminum powder in specific proportions to yield steel with the desired carbon content. The highly exothermic reaction is carried out in a refractory container channelising the heat generated for the melting operation. The ignition is initiated with Diwali sparklers or magnesium wire. Interestingly, the process is not amenable to up-scaling and appears to be viable only in very small quantities as are envisaged here. This “backyard steel-making” is envisaged to be used in artisanal Blacksmithy for value-added products or such other products as would be economically viable.

System Design

A system design comprising organization of production, product-market choice and other aspects, making a complete field model for production operations, is also an integral part of the technology package, thus forming a truly replicable model.

The existing pattern of working of artisanal blacksmiths is in smallish clusters typically of 2-3 family units in villages with concentrations of these artisans with, perhaps, one village in a Block/Tehsil having a higher concentration of, say, 10-15 households. In exceptional cases these numbers can go up to many times this number, some villages having 50 or more blacksmiths’ families, especially in specialty areas. Most individual smithies have their own furnaces and anvils, with the head of the household acting as Master Smith assisted by one or more family members depending on the size of the unit. Typically in a Block, there may be 6-8 villages having 2-3 blacksmiths units each and 1 village having a higher concentration.

A system design which caters to such typical clusters in a block-sized area would therefore have to be based on, and take advantage of, this spatial distribution of Blacksmiths. The organization of production has to be oriented more to the individual household-level smithy. At the same time, not all the facilities and equipment/machinery in the new technology package are necessary or viable at the individual household level and are preferably located at a nodal level. The system design worked out was as outlined above, with functions indicated in square brackets to be taken up in later stages:

Product/Market Scenario: At this initial stage of intervention, the product-market scenario would comprise the usual range of hand-tools and implements used by farmers, agricultural labourers and artisans in the field area as well as those domestic utensils and implements still being made by blacksmiths Efforts would be to also concentrate on those industry-made items which were currently being sold in the area so as to compete them out and assess the ability of the new technology package to be competitive in terms of both quality and price. Some specialty items of high demand would also be taken up in each area. At present, PWD and other major contractors executing civil works tend to procure implements such as spades, axes etc in bulk through tenders, a system, which clearly favours industrial manufacturers. Intervention in this sector can be taken up at a slightly later stage. Later still, value-added items and specialty tools could also be taken up. Further diversification towards casting, sheet-metal work to make storage containers, components (especially body/frame) for agricultural machines may be taken up even later.

Equipments and Tools: Equipments and tools required, and their costs (only illustrative) are shown in the Table (previous page).

Economics

An illustrative budget is given in the accompanying Table. Costs for functions proposed to be taken up at later, more advanced stages are not included.

Particulars	Cost (Rs.)
Casting and Forging Unit	
Drop forge	2,000
Mechanical hammer and furnace	12,000
Thermocouple	500
Pyrometer	5,000
Temperature control device	2,500
Welding Unit	
Welding machine (small capacity)	10,000
Abrasive cutter	3,000
Drilling machine (Bench drill)	15,000
Sheet metal cutting machine	2,000
Pipe bending machine	2,000
Miscellaneous Items	
Hardness tester	10,000
Biomass pyrolyser and Briquetting machine	10,000
Vernier callipers	500
Micrometer	1,000
Strolhein apparatus for carbon analysis and furnace	15,000

Economics	
Item	**Total (Rs.)**
Equipment/Machinery	
M/E (Rs. 20,000 x 10 smithies)	2,00,000
Other	36,500
Training	
Institutional	10,000
Field	30,000
Fees for Technical support	10,000
Materials & Supplies	25,000
As and when the Nodal Unit is set up, the following additional costs will have to be incurred (indicative):	
Qualified person (1) @ Rs. 6000 pm	1,44,000
Machinery & Equipment	50,000
Travel	20,000
Total	**2,14,000**

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