Understanding appropriate technology

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UNDERSTANDING APPROPRIATE TECHNOLOGY[1]

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1 Introduction

For too long, technology was considered to be a *magic wand*, which could solve the problems of society. In the last few decades this view of technology has undergone many changes, for it has been realized that technology, just as it can solve problems, can also create newer problems in society, sometimes of uncontrolled magnitude. During the last three to four decades both the developing as well as economically and technologically developed societies have been confronted by problems the roots of many of which can be traced, largely if not exclusively, to the choice of technology. The four major problems of this type facing developing countries are:(a) mounting unemployment; (b) rural-urban migration; (c) unequal distribution of the benefits of development; and (d) increased vulnerability to the policies of other nations. Until the present time in history, the three major problems faced by developed societies that raised questions about the choice of technology are: (a) alienation of human beings;(b) environmental degradation and pollution; and (c) rapid depletion of resources. This classification of the different problems of developed and developing societies is of course general and indicative only of the primary concerns. In many cases, however, the above problems are common to both groups of countries.

Appropriate technology is a concept, a set of ideas or a framework within which to think and act for a development of a society. The aim of the concept is to provide a basis and a method for the choice of technology. It is a concept intimately connected with development, whereby the development is of people rather than things, although the development of goods and services is seen to be a necessary appendage. The all-embracing nature of the concept has led

[1]This paper is published in **METHODS OF DEVELOPMENT PLANNING: Scenarios, Models and Micro-Studies, Eds: Sam Cole, Liliana Acero and Howard Rush, UNESCO Press, Paris, (1981),** *Figures 2 and 3 are redrawn by Adil Rasheed*

sociologists, economists, philosophers, technologists, planners and environmentalists to contribute towards its definitive descriptions. The concept leads one to discuss social issues like unemployment, population growth, rising inequality in society, urbanization, etc., in a new way. It questions the dominance of the economics relating to capital and income resources, labour-to-capital, capital-to-output and output-to-labour ratios, to economies of scale, to market and social prices, etc. In the sphere of technology, the concept questions the indiscriminate use of mass-producing western sophisticated technology and puts new constraints on the activity of production by insisting on the use of local materials and skills for local need and use. On a philosophical plane, appropriate technology relates to the concepts of peace, non-violence and permanence and stresses dignity and the ethics of work. Within the context of planning, the concept puts the emphasis on both short- and long-term policies that will encourage self-reliance, on bringing points of production and consumption (both in space and time) closer, and on decentralization with respect to planning and decision-making within the *regional approach.*

Appropriate technology thus is a normative concept. In order to understand the concept fully it is necessary to review notions about technology and development. This review is made below under the headings *Technology Defined* and *Strategies of Rural Development.* Three *case studies*, emphasizing different aspects of appropriate technology, are then discussed, on the basis of which a methodology of appropriate technology is derived.

2 Technology Defined

The term technology is often identified with the hardware of production and distribution, be it in the form of machines, factories, roads, storage facilities, telephones, etc. Technology, however, also includes software aspects such as knowledge, know-how, experience, education, organizational forms and management techniques [4]:

> *Societies that are technologically advanced owe their development not only to inventions and widespread application of new types of machinery but also to major innovations and gradual improvements in organizational forms and institutional structures. One of the major innovations in organizational forms in the first half of the last century was a legal invention, that of a public limited company. This new form of association allowed entrepreneurs to escape from the stifling restrictions of the professional guilds inherited from the Middle Ages.*

Formation of co-operatives in the socialist world and the creation of production brigades at commune level in China are other examples of innovations in software aspects of technology.

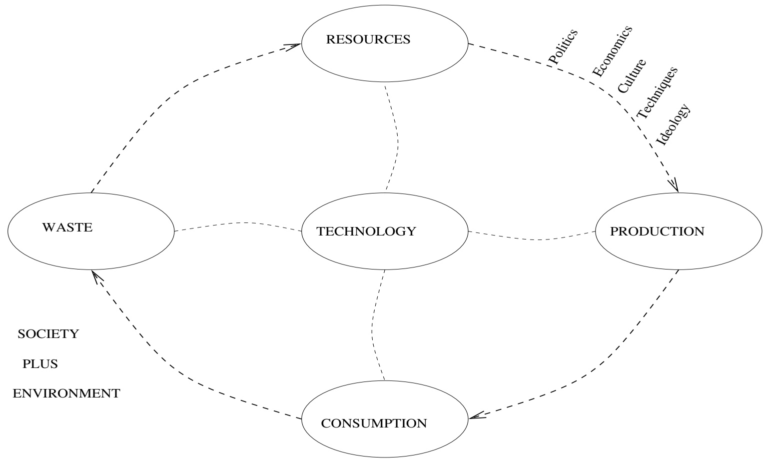


Figure 1: Technology and its Attributes

Another definition of technology which in some ways is complementary to the one above is that technology is the *skills, knowledge and procedures for making, using and doing things.* This definition in its broadest context includes all the activities geared to social production and distribution. It thus includes methods used in non-market activities as well as marketed ones. To put it another way, it includes activities for exchange as well as activities for use.

While these definitions take us much further than earlier, generally understood definitions such as *Technology is the application of science* and discard the identification of technology with industry, the definitions by themselves do not explain the role of technology in the dynamics of social change. Least of all do they answer the question; what is technology for? The definitions are still framed within the notion that technology is only for the satisfaction of consumer needs/demands of the people. However, other notions are also possible. For example, instead of viewing the majority of people as mere consumers, they can be viewed as creators, and technology can be seen as a *social learning* process feeding and enlarging the creative talents of human beings.

Technology can also be looked upon as a social activity in which men and women act for sustenance and maintenance within a cycle of the four main attributes of technology, as shown in Figure 1. While these four attributes are quite understandable in a material-technical sense, they need to be viewed in a much broader perspective. A successful technological society should continuously find ways to maintaining the cycle between resources, production, consumption and waste. This must be achieved on the basis of environmental stability and least-adverse impact on the manner in which people can best relate to the means of production and the products of their work. It is important to recognize however that both technology and society change simultaneously (as they must) and that the linkages between the four attributes are continuously influenced by elements internal to technology (the laws of physics, for example) by the political environment as shaped by such factors as ideology, bureaucracy, ownership patterns etc., by economics and by culture. Seen in this light, any discussion of appropriate technology can only be meaningful if the inappropriate nature of this social activity is understood. Also, what is implied by alternative technology is not merely changes in technique but also a change in the factors which variously influence the linkages between the four main attributes of technology. What follows from this argument is that not all technical change will necessarily result in a social change in the desirable direction, and hence lead to development.

Many analyses of technology-society relationships are based on *determinist* models in which one factor (technology, economics, politics or ideology) is picked out as determining everything else Roy, [7]. Technology determinism suggests that social development is solely a function of the technological changes that a society invents or adopts. Societies are thus classified according to the state of technological development they have reached, e.g. Stone Age, Iron Age, Atomic Age, Computer Age, etc. It follows from this model that all societies with similar stages of technological development will be similar in all other respects and that the lag between the underdeveloped and developed societies can be immediately bridged by adoption of the technology of the developed societies by the underdeveloped societies. The model, however, fails to explain why many societies with comparable technological developments exhibit marked differences in the context of social development.

Economic determinism, by contrast is based on the idea that technological changes are controlled by economic and commercial forces rather than solely technological ones. According to this view, the state of technology at a given place and time is solely governed by economic factors (like land, labor, capital and markets). The model also suggests that there is always a range of techniques (exhibiting different factor proportions) available to satisfy a give need. In capitalist societies, where economic criteria are dominant and the price mechanism greatly influences the activities people undertake, the model goes a long way in explaining the choice of technology and the direction of technological change.

The political determinist model suggests that technological and economic considerations are themselves manifestations of the political forces prevailing in a society. Technologies developed and adopted by a society reflect the interests and values of the more powerful and influential individuals, groups and institutions of that society. Ideological determinants of technological change are often the least obvious, being governed by hidden sets of belief and premises which taken together make up an ideology.

It would be futile to think that all technologies are developed or that all technological change occurs under the influence of only one of the determinants. In fact, more often than not, technologies are chosen by a combination of all the determinants, although one of them may be more influential than the others.

The above discussion, one hopes, makes it clear that technology is a social activity and thus is an integral part of the social system. Understanding the nature of technology in the above manner provides the basis for discussing the more normative issues like *development* and *appropriate technology.*

3 Strategies of Rural Development

In many developing countries in recent years attention has been directed towards evolving strategies with particular emphasis on rural development. The need to recommend new strategies (see, for example, Haque et al. [3], Kothari [6] and Subramaniam [11]) arises from the disenchantment with past strategies of national development, the three major components of which were: (a) central planning, control and co-ordination of the economy as a top- down process; (b) industrialization and expansion of the modern sector as a means of rapid economic growth; (c) aid from developed countries and transfer of international technology.

It is now scarcely disputed that this strategy has promoted dependency culture and has led to the *continued exploitation of peripheral areas by the metropolitan core, both internally and externally.* The strategy was largely based on the percolation theory of the distribution of the benefits of rapid economic growth. The fact that over 60 per cent of the people (primarily in rural areas) still continue to live below the poverty line has led to disenchantment with this *technocratic* and *bureaucratic* strategy of development.

The large percentage of the population living in rural areas, the prime necessity for prosperous agriculture for self-reliance in food, the decreasing land-man ratio in the wake of alarming population growth, the incapacity of the modern industrial sector to augment employment and the continuously declining purchasing power of the rural poor are some of the parameters which indicate that *solutions to basic problems of underdevelopment must be found in the countryside.* The debate now is between the *reformist* and the *radical* strategies of rural development. The strategies differ in *objectives, ideology used to mobilize support and in the way benefits of economic system and growth are distributed.* Wahidul Haque et al. [3] thus remark:

The debate is between reformists who believe that the system can still be made to work if equitable distribution is built into what is essentially a growth model and those who favour a radical approach, redefining the objectives of development in the direction of rapid social change and redistribution of political power. The reformist position ... maintains that (a) there is no real conflict between growth and equity and (b) that redistribution with growth is technically, economically and politically, feasible under existing conditions in the Third World ... If the problematique *of development is cast in the form of a conflict between growth and social justice, it may be possible to make a case that a continuous process of transfer of an appropriate proportion of the income from the rich to the poor* *would remove extreme poverty in the long run .... The essence of (this) approach (however) is antithetical to the flowering of developmental values - creativity, self-reliance, non-alienation, democratic decision-making - which are true measures of social development. Benevolence cannot generate self-respect and without self-respect there can be no healthy society ... the issue is the development of man, who is both the end and the basic driving force of production, a point that has been side-tracked by looking at the problem of development as one basically of capital constraint.*

In defining the objectives of the two approaches in the above manner, different actions-options emerge. These options relate to the processes of (a) participatory planning, (b) creation of political leadership rooted in the masses, (c) land reforms, (d) institution-building, (e) reorganization of geographic space towards achieving social continuum, (f) remoulding of elites and their life-styles, (g) transformation of attitudes and methods in technological research, (h) adaptation and dissemination calling for development of appropriate technology and (i) reorganizing education such that work, learning and mass-contact are considered essential to the creation of manpower that sees itself as a positive contributor to the process of development and reduction of inequality rather than as earning a passport to privilege.

The radical and reformist strategies while agreeing on the action options differ in the manner of implementation of the options cited above. The reformists propose *policy incentives* and oddly enough, even *authoritarian coercion* in the hope that a clear demonstration of the latter action can itself be a propellant for change. The radicals see the implementation process essentially as a struggle game; because the transformation suggested by the options would *hurt certain sections of society and would naturally be resisted*. Happily both the reformist and radical strategies recognize the importance of technological transformation. What the content and the methodology of this transformation should be is really the task before the practitioners of appropriate technology.

4 Some Case Studies

Those interested in its generation and diffusion must understand that appropriate technology has to be appropriate to development, understanding development not merely as economic growth but as socioeconomic change primarily directed towards the following (Reddy, [8]):

1. Satisfaction of basic human needs (food, clothing, shelter, health, education, transport/communication, etc., and employment which makes all this possible), starting from the needs of neediest, in order to reduce inequalities between and within countries;

2. Social participation and control in order to strengthen self-reliance that grows form within and to prevent concentration of economic and political power; and

3. Ecological soundness in order to achieve harmony with the environment and make development sustainable over the long run.

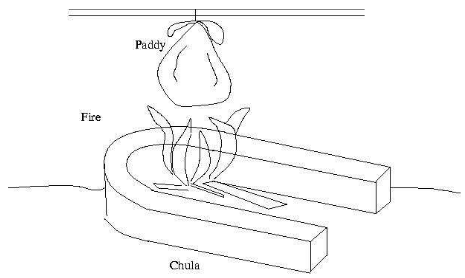
The process of generating appropriate technology solutions has only just begun, and practitioners face many difficulties. The most successful examples of appropriate technology are those which are developed spontaneously within a community in response to a given need. This spontaneity is, however, a rare thing because of lack of knowledge, for one thing, and because of the many historic and socio-political factors at work within a small community. Outside intervention thus becomes almost inevitable if the development of those who belong to the non market economy (i.e. the neediest people, those without purchasing power) is considered urgent. The intervention has a triple objective: first, to enable the community to perceive its needs more articulately; secondly, to acquaint the community with improved methods of doing things; and thirdly to *conscientise* the community about the socio-economic and political forces which hinder its development.

Even for those needs of the society that are transformed into demand through purchasing power, the truly appropriate technologies for satisfying them are *filtered* out of the possible range of technological options. This is because of the lack of knowledge available to the decision-makers at the appropriate time and place and also because certain forces consciously assist this filtering process. In addition, not all the development promoting characteristics of the technology can be quantified: as a result, comparisons between two or more technological options become increasingly subjective. Practitioners of appropriate technology therefore face the task of presenting the technological options in as objective a manner as possible.

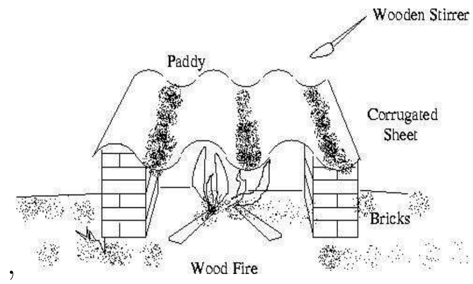
Often the needs of the weakest sections of society are approached in technical terms in such a way that technical solutions are not always possible; or if the solutions are possible, social conditions are such that the benefits of technical change will not acrue to the weakest because of lack of social control. One of the tasks facing appropriate technology practitioners is to identify the needs correctly so that benefits will truly reach the neediest. In what follows, three case studies are described which highlight the nature of the problems dealt with by appropriate technology.

Example 1: The Rice Paddy Drier

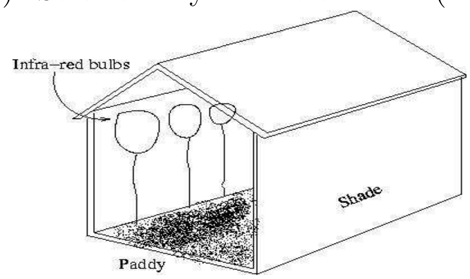
In recent years, quick- and high-yielding varieties of paddy have been recommended for single-monsoon, rain-fed agriculture areas. Quick yielding varieties



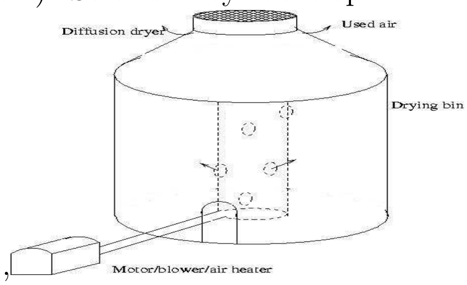
(a) Solution by farmers



(b) Solution by development agency



(c) Solution by agricultural research station

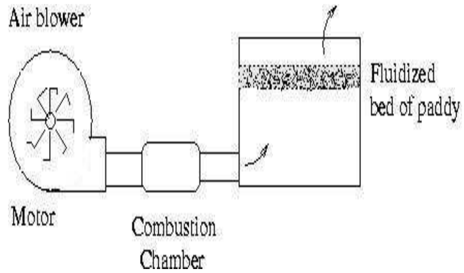


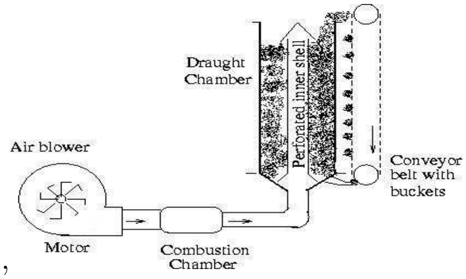
(d) Diffusion drier

Figure 2: Continued on Next Page

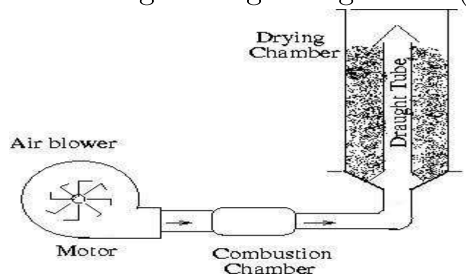
mature in 90 to 100 days as against 125 to 135 days for middle and late varieties. The early varieties allow use of rain water for twenty-five to thirty days towards the end of the monsoon by vacating the land for leguminous or vegetable crops. The early varieties have a short dormancy period (up to seventy-two hours) and if not dried quickly after maturity, the paddy begins to germinate. Since sun-drying is not possible during the monsoon, farmers have lost 30 to 40 per cent of their crop through germination. It is for this reason that farmers do not opt for extensive cultivation of early varieties of paddy. The need to cultivate early varieties paddy, however is particularly great for small and marginal farmers, for it allows them to stay their hunger as soon as possible. In the absence of a suitable means of drying their crop, small and marginal farmers commit only a part of their (typically 2.5 acres and less) land to early-variety paddy. If a mechanical drier were available not only would crops be saved, but farmers would also be encouraged to take two crops from their total land.

Work on finding an appropriate technology solution to this problem began at IIT Bombay as a result of the author's field visit to a voluntary development trust near Bombay which worked for the uplift of adivasi farmers. The trust set up a farmers' society (initially there were six members, but in subsequent years the number rose to 400) and the problem of drying was identified by the farmers and field-workers of the trust through a series of dialogues. The trust had acquired electricity connections and had established credit-worthiness with the nationalized bank.





(e)Solution by agricultural engineering college (f) Moving bed drier



(g) Present solution

Figure 2: Alternative Drying Solutions for Paddy

Currently, the farmers obtain about 100 kg/acre of early-variety paddy and the total yields are 800 kg to 1000 kg/acre. The farmers live in small hamlets with populations varying between 100 to 500 and land holding varying between 25 and 100 acres. The yield of the early variety of paddy thus varies between 2 and 10 tons per hamlet. This much paddy must be dried in ten days. It is quite possible that, if farmers were satisfied with the drying technique proposed to them, they would prefer to plant greater quantities of early-variety paddy. Therefore the drier design must be amenable to an augmentation in its scale (to about 25 to 100 tons of paddy in ten days) without excessively increasing its cost and sophistication. The farmers would also be interested in using the drying for late varieties (which are dried in the sun and which have poor milling characteristics, in addition to incurring considerable handling loss) which mature in late October, to obtain greater yields after milling. All these constraints and requirements emerged through a dialogue and therefore the technical specifications for the drier were as follows:

1. Capacity per day: 0.5 tons to 10 tons.
2. To be simple to construct and operate by farmers themselves.
3. To use hot air (around 60C) for drying to impart uniformity of temperatures, which consequently imparts good milling and storage characteristics.
4. When the demand for the drier increases, the smallest-capacity unit must

be amenable to an increase in the scale of operations without greater sophistication and without additional constructional and operational difficulties.

5. Since drying is a once-a-year operation the capital cost of the drier must by as low as possible.

After specifying the problem in technical terms, the spectrum of drying techniques was scanned in terms of capacity/batch, drying time, area requirement, uniformity of drying, mechanical and constructional sophistication, ease of operation, possibilities of self-help in construction at operation, suitability to purpose (consumption, market or storage), known users of each technique, pressure-drop and heat-mass transfer characteristics for paddy grains, etc. Figure 2 shows the different drying techniques surveyed. More detailed description of the merits and demerits of each of the techniques can be found in Date [1]; here it will suffice to mention that none of the techniques was found suitable for the conditions prevailing in the area of interest. Hence the spouted-bed technique with draft-tube modification (see Figure 2(g)) was thought of. The modification was essentially introduced to achieve the following: (a) to alter the cumbersome start-up pressure-drop characteristic of the conventional spouted-bed technique; (b) to reduce the stringent requirement of geometric accuracy; (c) to reduce the sensitivity of control on drying air temperature; (d) to ease the operational procedure; (e) enable self-help in the construction and operation of the drier while still using the efficient moving-bed technique for coarse paddy particles.

The holding capacity of the drying chamber is 85 kg of paddy grain, which is the content of one bag of paddy. After field trials it was established that the performance rating of the drier was 1.8 tons/hp-day. The costing of the drier shows that beyond 5.4 tons/day capacity there were no significant economics of scale obtained without an increase in constructional complexities. The increase in scale of drying is to be achieved by multiplying the basic unit. When compared with the benefits obtained from increased (7 per cent) milling yield and saving in field losses, even the smallest drier is economically attractive. The drier has also been demonstrated outside the target area to study the possible mechanisms of transfer for wider diffusion. The parties to whom the drier was demonstrated were: (a) local leaders; (b) block development officers, agricultural extension officers, and bankers; (c) local political-party workers; (d) rice-mill owners; (e) marginal farmers; (f) voluntary development workers. The demonstrations have shown that:

1. Since drying is a pre-milling post-harvest operation it should be viewed as technique related to use-value.

2. The technique will have to be suitable adjusted for collective or individual drying.

3. Since drying is a once-a-year operation, commercial mechanisms for transfer would be ineffective.

4. Establishing an industry to manufacturer the drier would be ineffective in terms of initial costs since all the economies of scale obtained would be lost to the poor.

5. Transfer of the drier through established government channels was favoured but there would be much red tape; moreover, involvement by the poor in the construction and operation of the drier would be absent.

6. The political leaders and rice-mill owners wanted a bigger-scale drier so that they could own the drier and *serve* the community. They saw in the drier an effective instrument of control over the production process.

7. The marginal farmers showed much interest and great appreciation of its simplicity in construction and operation.

8. The voluntary development workers felt that if participation and social control were of importance, the best mechanism for transfer was through them and they would favour a do-it-yourself manual on the drier. They agreed, however, that a large mass of farmers in need of the drier could not be reached in this way.

Example 2: Paper Production in India

About 50 percent of the total demand for paper in India comes from the printing of textbooks, school notebooks and other stationery uses. Paper can be produced in small units with a low capacity using totally manually operated machinery up to the scale of 500 tons/day using sophisticated machinery. The largest factory in India produces 200 tons of paper per day and other units of 200-250 tons/day are under various stages of construction/planning. Sidhu [10]

The Regional Research Laboratory in Hyderabad has developed a 5 tons/day paper plant. In Table 1 three types of paper plant are compared[2] : 1. A handmade-paper plant run by Khadi and Village Industries Commission, India: capacity, 240 kg/day. 2. A plant developed by RRL, Hyderabad: capacity, 5 tons/day. 3. A typical large-scale plant: capacity, 100 tons/day.

The paper plants are compared in terms of criteria that highlight economic factors, environmental considerations, self-reliance, suitability for use of agro wastes, energy-intensiveness, possibilities for decentralization and income distribution, and opportunity for self-management. In terms of characteristics conducive to appropriate technology, clearly 5 tons/day paper plants are attractive. The lessons of the table are self-evident, but a few points are worthy of note.

[2] Water requirement is calculated at the rate of 80000 gallons per ton of paper

Table 1: Comparison of paper plants

Item	Capacity per day		
	240 kg [5]	5 tons [10]	100 tons [10]
1. Capital cost / ton	Rs 13.1 lakh	Rs 15 lakh	Rs 40 lakh
2. Capital/work place	Rs 3490	Rs 50000	Rs 1.3 lakh
3. Number of people	90	150	3000
4. Output/worker/day	2.66 kg	33 kg	33 kg
5. Cost of Prod/ton	Rs 6970	Rs 3000	Rs 2800
6. Int and Depreciation/ton/day	Rs 510	Rs 530	Rs 2000
7. Time to set up	Max 1 year	2 years	5-7 years
8. Raw material	Cotton rags, wheat starch, old gunny bags	Agro-waste like rice/ wheat straw grasses, cotton linters	Bamboo and hardwoods
9. Water requirement gallons per day	18000	400000	8 million
10. Possible location	Village, taluka small town	Taluk, small town	Large Town city
11. Machinery	can be made in taluk, district workshops	can be made in India without foreign collaboration	can be made by large industry with foriegn collaboration
12. Transport	Bullock/hand carts	Bullock cart/truck	Truck-cum-rail
13. Effect on environment	Scattered and hence small	Scatterd and hence small	Concentrated hence large

It is true that large-scale plants can also utilize agro-wastes, but these are so light and bulky that their transport beyond 50 km becomes uneconomical; instead it is preferred to transport bamboo (1.5 to 2.0 tons/ton paper) over distances of 300 km and more by using rail and truck transport. The small plant requires less capital per work-place and would thus have a favourable impact on employment. Also, since capital cost/ton is also small, the plants can be set up in large numbers, creating a sustained demand for machinery, thereby reducing the cost of machinery further. Sidhu et al. [10] thus determined that the best option for India is to set up *a few large mother-pulp mills to feed paper mills of standardized capacities of 20 to 50 tons/day and to set up a very large number of integrated agro-waste based paper mills of 5 and 10 tons/day capacity.*

Example 3: Palmyra-tree climbing device

One of the tasks involved in finding an appropriate technology solution is to convert the felt need into a solvable technical problem. This is often not an easy task, and the need, however correctly identified in human terms, may not be met by a technical solution if the technical problems are not correctly specified. We consider here the problem of the palmyra tree climbing device.

At present there are 13 million palmyra trees in India, of which only 4 million trees grow close together. The remainder are scattered, growing on undulated and sometimes marshy lands. Where trees grow close together the tapper is able to tap 70 to 100 trees/day, as the trees are connected by ropes and the number of climbing is few (see Figure 3(a)). The tappers earn between 7 and 10 Rs. per day. In scattered-tree areas a tapper is able to tap only 25 to 30 tree per day (as each tree has to be climbed twice, once for tapping and once to collect the juice, which means sixty climbings per day). The average earnings of the tapper are thus only 3 Rs. per day. Being a hazardous job with very low earnings, this activity is avoided by many young people. The agency responsible for tapping therefore sought designs for a climbing device which would increase the safety of climbing as well as increase the productivity. At present the tapper holds the tree with two hands and feet with loops of coconut fibre or sisal-fibre rope round his arms and legs for added safety. The various designs suggested are shown in Figure 3.

Figure 3(b) shows the use of long-handled iron pliers to provide a better grip, without the hands touching the tree, and to enable a longer leap. The pliers were, however, found unsuitable since the girth of the tree varied over its height and different trees of different ages have different diameters. Also, since the tapper had to carry increased weight with him as he climbed, he quickly got tired and his productivity dropped.

Figure 3(c) shows the suggestion of a rope and pulley block to be fitted on each tree to obtain mechanical advantage and increased safety. The drawback is that mechanical advantage can only be obtained at the expense of increased time and hence this does not increase productivity. Also, the safety of the pulley block and ropes in scattered-tree areas cannot be guaranteed.

Figure 3(d) shows the suggestion of fixing a tube to each tree and collecting the juice at the bottom so that at least one climbing can be reduced. However, the juice on the tube walls would ferment unless the tubes were washed regularly, which in scattered-tree areas would be very cumbersome.

Figure 3(e) shows the suggestion of a power ladder mounted on a diesel vehicle. In this case, undulating or marshy terrain might prevent its use and it would also be an extremely costly solutions.

It thus seemed that no solution to the climbing-device problem was attractive enough. Hence the problem was tackled differently.

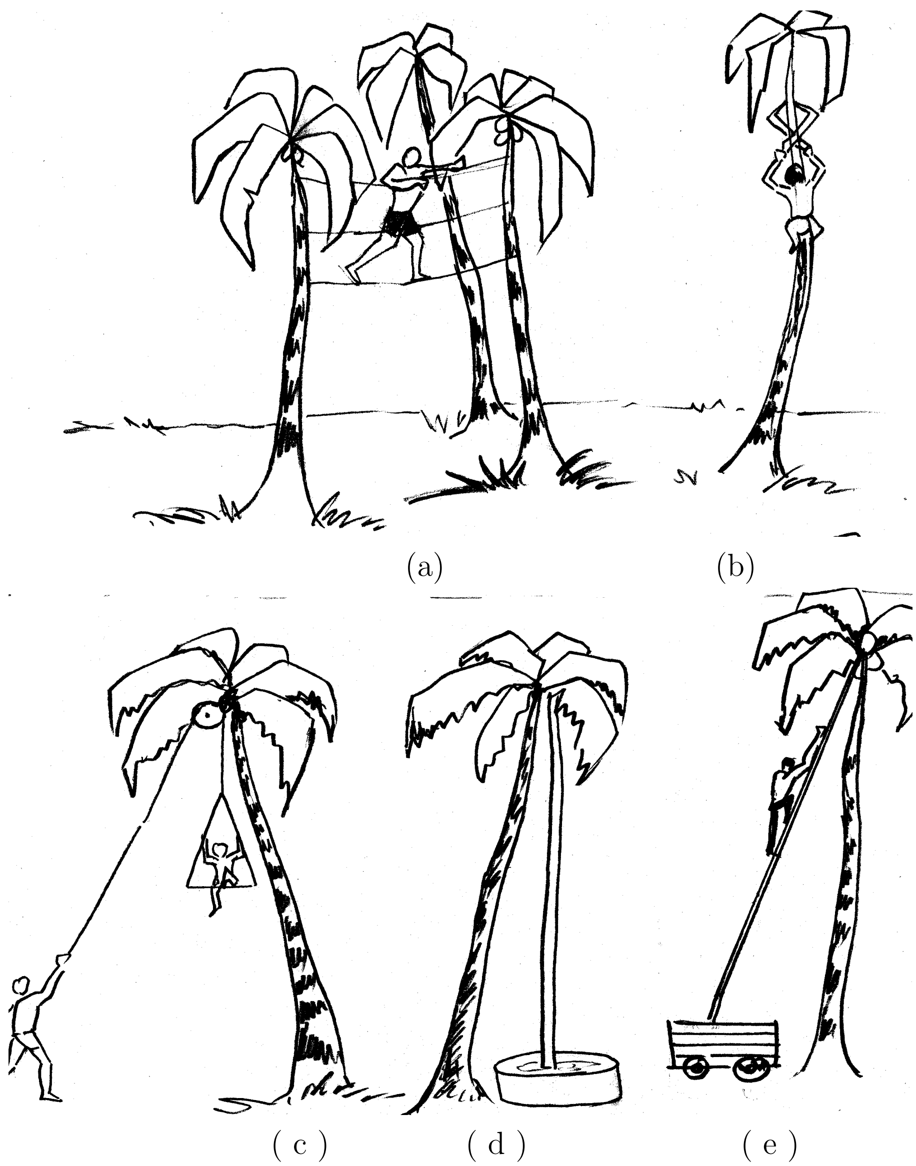


Figure 3: Alternative Solutions for Palmyra Tree Climbing Device: (a) Rope-ways for closely packed trees (b) Pliers for better grip and increased leap (c) Rope and pulley block for mechanical advantage (d) Tube for draining juice (e) Powered ladder for climbing

Under Indian conditions, it can be estimated approximately[3] that about 750 kcal/day may be expended by a tapper (weight of tapper 50 kg plus 5 kg load consisting of tapping tools, etc.). typically, for climbing a 15-meter-tall tree nearly 18 kcal are required, which suggests that 750/18 = 42 climbings, or 21 trees, per day is the best productivity that can be obtained. The current productivity of 25 to 30 trees per day is therefore more than satisfactory. Second, if a time-and-motion study of the climbing, tapping, descending and walking up to the next tree is carried out, it turns out one would need 5.2 minutes. If it is assumed that the tapper will work for six hours, then a maximum of 60 x 6/5.2 = 70 climbings per day is possible. Again the present productivity seems adequate.

As such, any solution which meant carrying more weight would not increase productivity. Other solutions were also not feasible, for the reasons quoted earlier. The possible solution to the problem of increasing the earnings of tappers would be to involve the family of the tapper in primary processing of the juice. This would be possible if middlemen were removed. Any thought of increasing the earnings through increased productivity in tapping is unrealistic.

5 Methodology for Appropriate Technology

From the previous discussion and the case studies, one may generalize the methodology for appropriate-technology solutions as a series of steps. These may be briefly written as follows:

1. Identify the felt need.
2. Specify the surrounding conditions so as to determine the level of collectivity of people associated with the need and also determine other relevant limit situations.
3. Convert the need into a solvable technological problem.
4. Scan the spectrum of technical solutions available.
5. Choose from the spectrum or else innovate a new technical solution through research and experimental development.
6. Practise micro-diffusion.
7. Search for transfer mechanisms for wider diffusion.

In the paddy-drying problem the need was identified at the level of collectively of a hamlet. The manner in which this was done was through dialogue in a

[3]Books on Ergonomics provide no information on maximum energy expendable in climbing trees. hence, the approximation

situation where a voluntary development agency had already done work which brought about co-operation between people in several activities in the villages. It is important to emphasize that the involvement and participation of people in the identification of their need is a process of education which leads people into an association with the satisfaction of that need. The dialogue approach defines the surrounding conditions and is the most important step in the understanding of appropriateness.

Once the need (at the correct level of collectivity) as dictated by the surrounding conditions, is identified, the next stage is to specify the problem in technical terms i.e. specification of performance criteria, capacity, productivity, output rate, etc. In the drier problem the technical specification was arrived at again through dialogue, which dictated, for example, not only the immediate capacity but also the incremental capacity as the confidence of the people grew in the drier. Often specifications of problems are derived from the point of view of abstractions called variously *recent trends*, *market*, *economies of scale*, etc. Sometimes these abstractions act as filters against specifications of problems which truly correspond to the need. Techniques derived in this fashion have also often disrupted local cultures and environments. In addition, when the problems (or needs) are identified in this way, problems end up being specified in terms for which no feasible technical solutions are possible. For example, in the palmyra-tree climbing-device problem the need was identified in technology-deterministic ways, even when no technical solution was possible and the solution lay in finding software (organizational) innovation rather than in the hardware.

The third stage is the search for alternative solutions. The search often leads to a very large spectrum of possibilities. To a great extent the choice should be made in consultation with the people concerned. When the affected population is large (as in the case of irrigation or afforestation, for example) a form of referendum is necessary. The referendum must, however, be preceded by dissemination of knowledge among the people. This calls for new forms of communication and information systems as well as institutional set-ups. This subject is vast and will not be dealt with here. However, it would be appropriate to mention that in many developing countries one-to-many forms of communication systems dominate over many-to-many or many-to-one or one-to-one forms of communications systems. While monologue forms of communication exist, the development will fail to consider the needs of the majority. The choice-of-technology difficulty usually poses two kinds of problems. The first is when a technical solution is available but its appropriateness to a given situation is to be determined; the second is when a new innovation is necessary. The first type of problem may be seen as that of technology assessment for which quantitative analytical techniques are necessary. In both types of problems, contrary to the general belief, a high science content is required.

The broad set of criteria listed by Reddy [9] can serve as extremely valuable guidelines in the choice of technology problems. In a particular case, however, these need to be defined more specifically, as was done in the example of paper production in India. It is important to note that when alternative technologies are compared only the economic criteria are normally considered or are predominant. This is not surprising, since the choice of technology has often been made in terms of contributions to GNP, profitability, and final price to the consumer. Other types of criteria are essentially qualitative in nature and hence are often overlooked. However, it is important to emphasize that the qualitative criteria are the ones which relate more directly to concerns about decentralization, income distribution, environmental impacts, energy intensiveness, self-reliance and so on.

What should not be overlooked, of course is that technology derives its appropriateness not only from correct identification of needs and from the strictness with which the choice criteria are observed but also from the manner in which it is transferred and used. Transfer of technology can be viewed in two ways. One is that in which people are assumed to be mere consumers of technology. The transfer mechanism of the market type, which works within a legal and commercial framework, is usually of this type. The transfer of technology can, however, also be seen as a *social learning* process. While for many capital and consumer goods the market mechanism works well, it cannot be used in all cases. In developing countries, for the mass of the people, both the incomes and the need for artifacts of production are seasonal. As such, commercial production of items to serve seasonal needs becomes extremely difficult. Whenever such an attempt has been made, the production has usually been discontinued. The non-market participatory and learning transfers, however, at present appear to connote voluntarism. This process of transfer also does not replicate itself very easily. There is thus an urgent need to generate institutional and policy frameworks for bringing this about. It should not be overlooked, here, that at a fundamental level this signifies a change in political economy. When production relations change, the vested interests play a dominant role. As such, whenever consideration to the problems of transfer and use of technology is not given, well-intentioned alternative techniques either are not implemented or are misused, leading to further imbalances in the society.

6 Conclusions

To summarize very briefly, appropriate technology is a normative concept which derives its definition and methodology from clear understanding that technology is a social activity. Appropriate technology is neither another exercise in technological determinism nor is it a search for a new *technological fix* (Dickson, [2]) but is truly a search for an alternative technology and an alternative society simultaneously.

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