

## Bamboo — solution to problems

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**Abstract**—The world is facing a number of problems to which bamboo could provide a partial solution. There is a near certainty of wood shortage in the near future. Compounding that is the withdrawal from wood production of forests for conservation reasons. The world population is becoming more urbanised. When employment is provided in rural areas there is a wish that it should have the appropriate scale and adequate local participation in decision-making.

Thus, to have a partial impact on these problems, a solution is needed that has the following characteristics:

- A product can be produced that substitutes for wood in the widest range of uses.
- The production of that product has positive environmental impacts.
- The product can be made in a rural environment to assist in reducing the pressure of urbanisation.
- The scale of production should be such that rural people are not displaced by it and can participate meaningfully in the activity.

Development based on bamboo can very definitely provide part of the answer. Bamboo products do substitute very widely for wood-based products. Bamboo is an easy plant to raise and can be grown in small clumps on under-used land on farms. Raising it therefore has the appropriate scale for people's involvement. Bamboo is kinder to the environment than many agricultural crops. Bamboo industries moreover can be created at craft level with maximum villager involvement and relatively low capital requirements. Bamboo based industries can therefore provide the time and space for evolutionary development of the rural economy.

*Key words:* Bamboo; environment; industry; craft industry; substitution.

### THE PROBLEMS

- (1) The world produces 3.5 billion tonnes of wood from roughly 3.5 billion hectares of forest [15]. Approximately half of that is used as firewood. In the developed world, less than one billion people consume an average of approximately

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1 tonne per capita per year, hardly any of it as firewood. The richer the country, the higher this amount (in the USA it is 2.3 tonnes). Thus, in the poorer parts of the world, people consume far more firewood than industrial wood (by a factor of at least three to one).

The overall objective of world development is that standards of living should rise. At the present, China's annual per capita wood consumption is only  $0.16 \text{ m}^3$  — much lower than the global average of 0.65 cubic meters (China Daily, 13 April 2000). Will the developing world start to consume wood in a manner similar to the developed world as it becomes richer [16]? The evidence is not clear but South Korea has seen a quadrupling of its per capita consumption between 1950 and 1990. Although China's per capita lumber consumption remains much lower than the global average, its demand for lumber has increased drastically over the last few years, while its supply has remained steady or decreased slightly (China Daily, 13 April 2000). Will new technology (email and Internet) reduce the amount of paper used? Again the evidence is not clear but there seems to be no strong trend as yet.

The consequences for world wood consumption are therefore very serious if rising standards of living lead to an accelerated usage of wood products [10]. If the world population (six billion now trending towards eight billion in 25 years time) moved to consume wood in a pattern similar to the more developed countries (e.g.  $1 \text{ m}^3/\text{capita}$  in Germany [11]) the consumption of industrial wood (excluding firewood) would need to at least quadruple (as it did in South Korea). It is unlikely that the wood currently consumed as firewood could assist much, for well-known technical reasons (it is often dead wood, small sized and sparsely distributed).

- (2) The area of forest is being reduced by continuing deforestation. This is compounded by a growing consciousness that forests have values over and above their timber value (for carbon retention — mature forests may not actually sequester extra carbon — for biodiversity shelter and for soil, water and air quality values). Thus the supply of timber-producing forest is decreasing, through preservation, in such diverse economies as the USA [9], Australia, New Zealand [2], India and China.
- (3) In the last two centuries, improving standards of living have been preceded by large increases in population and increasing urbanisation. It is paradoxical that the population appears to increase rapidly before gains in living standards appear and that steeply rising population can threaten to cancel out those gains. Developing countries are following along the pattern first established in Britain 250 years ago but with some differences. The English population rose from 6 million in 1750 to 40 million in 1900 but would have increased to over 60 million were it not for the huge outward migration to the US, Australia, New Zealand and South Africa. Even with that safety valve, small villages like Birmingham increased from populations of only 4000 in 1680 to 400 000 in 1881, as people left the countryside for the towns [17]. They had little

choice. There was not enough free land in the countryside for farming. Living conditions for most of the population in these cities were very poor and their working conditions dehumanised. Today's developing countries do not have the possibilities of overseas migration; they face the same pressures towards urbanisation but do not wish to reinvent the 'dark Satanic mills' [1] of the 18th and 19th century. It would be good if sufficient employment could be found in a rural environment to reduce the pressure towards urbanisation.

- (4) Studies in both the developed economies and the developing economies have come to the conclusion that people work best in small to medium size firms/enterprises where they can see the impact of their own efforts and where they feel that they can have an effect on decision-making. These conclusions find their expression in the general concept of 'participation' [8, 13].

Thus, to have a partial impact on these problems, a solution is needed that has the following characteristics:

- A product can be produced that substitutes for wood in the widest range of uses.
- The production of that product has positive environmental impacts.
- The product can be made in a rural or semi-rural environment to assist in reducing the pressure of urbanisation.
- The scale of production should be such that rural people are not displaced by it and can participate meaningfully in the activity.

## THE SOLUTION

One would not wish to suggest that the cultivation of bamboo is the only or a total solution to the problems outlined above, but experience in China and elsewhere shows that it can make a meaningful contribution.

### *The growing of bamboo*

Bamboo is a very tolerant plant. It requires adequate rainfall to thrive but its various species will survive great cold, humid heat and mediocre soils. Many people believe it is a warm temperate to tropical plant, but bamboo is known in China as one of the 'Three Winter Friends' — a group of three plants (with obvious anthropomorphic links) that withstand harsh winter conditions together: pine, bamboo and wild plum. Bamboo is easy to propagate and tend.

Because of this ease, bamboo propagation and growing can be small scale, low capital, and integrated with other farm activity. The landscape of areas like Anji in China demonstrates this perfectly. Thus bamboo need not replace other farming activity and bamboo can be sited on parts of the farm unsuitable for other crops however small those areas be.

One can only contrast this with plantations of tree species. Because there is no really good model for farm-grown trees (forest trees tend to need large dense stands

in order to retain desirable wood qualities) and because the capital requirements and complexities of tree afforestation are greater, tree plantations tend to be established in a dense blanket across the landscape, entirely replacing other activities and worsening rural ex-migration.

Bamboo clumps and even bamboo plantations have several good environmental characteristics. Crown height is low (relative to trees) and leaf size small. Tall trees with large leaves (e.g. teak) can concentrate rainfall and increase soil erosion [3]. A closed bamboo stand weighs around 100 tonnes/ha (e.g. 76 tonnes [4]; 47 tonnes [18]) so does not stress weak soils. Bamboo is selectively harvested so the stand remains closed at all times, protecting soil and water. By contrast, tree stands at maturity weigh much more and tall trees can over-turn by themselves, leading to soil damage. Tree stands are typically clearfelled leading to periods of low soil cover. Soil loss is highest in association with tree harvesting. Bamboo, on the other hand, seems to help in nutrient cycling [5].

Individual bamboo culms are relatively light in weight and can be easily handled away from their growing site to a primary-processing location. Thus the bamboo industry can be labour-intensive but on a small scale. By contrast, trees at felling can weigh 1.5 tonnes or more each — at which weight they defeat attempts to move them with simple, low capital equipment. Tree felling by contrast therefore tends to be undertaken by capital-intensive machines driven by trained staff from outside the district where the trees are grown.

Yields of bamboo have been reported to exceed 25 m<sup>3</sup>/ha and often exceed 10 m<sup>3</sup>/ha [18], thus equaling the level of yield achieved from fast-growing plantations. Bamboo has one significant advantage however — it only takes three years to reach maximum volume.

### *Bamboo as a wood substitute*

The bamboo culm, reduced to its finest parts, is an excellent industrial fibre. As such it has been shown, both in the laboratory and in practice, to be an excellent substitute for wood fibre in such things as paper, medium density fibre board and veneer. There are very few technical difficulties in utilising normal wood-working machinery to work with bamboo. One difference that does need to be accommodated is the higher silica content of bamboo which can dull cutting edges [14].

With good physical and mechanical properties, low shrinkage and average density of 0.7 g/cm<sup>3</sup>, bamboo is well suited to replace wood in several applications, especially in panel form. Bamboo mat board and bamboo strip board have been exploited on an industrial scale, and products marketed for various end uses such as flooring, roofing, and other housing components, furniture, packing cases, etc. At present, in China, over 1 000 000 m<sup>3</sup> of panels of various types are produced annually in some 200 mills, whereas in India, industrial-scale production of panels is confined to bamboo mat board with about 2000 m<sup>3</sup> board by seven mills.

The global use of paper is reported to be increased by 5% annually. Today, Asia, and mainly India and China, make the most use of bamboo for pulp and paper.

India uses about 3 million tons of bamboo per year in pulp manufacture and China about 1 million tons, and both are set to increase their use of bamboo for paper pulp manufacture (China targets 5 million tons per year). Bamboo pulp is also processed into incense paper in the Philippines for export. Brazil is presently the only American country that uses bamboo for making cellulose and paper.

However, bamboo has certain characteristics that are superior. It has a high surface hardness such that laminated bamboo flooring is equal in wear to the hardest American hardwoods.

Many of the products made from bamboo can be and are made in small factories with very limited capital requirements; hence these factories can be distributed around the country-side close to their raw material.

Bamboo also has a unique role to play in constructing strong light-weight houses [7]. It has been known for a long time that light weight timber frame construction houses offer the greatest safety against earthquakes [12] and also greater safety on earthslips. Lightweight timber framing housing is the norm in New Zealand. In 1987, the small town of Edgecombe in the northern part of the North Island of New Zealand was shattered by a force 7 earthquake. The force of the earthquake was sufficient to tip a railway engine on its side. Yet no-one was killed and all of the houses remained standing.

There are two technologies utilising bamboo that can be adapted to provide similar kinds of houses [7]. In one, bamboo poles can be used in a similar way to timber studs to provide a similar space-frame construction. More work needs to be done improving the joins before the result is as strong as a timber frame house. In the other, a bamboo frame or hurdle can be woven out of split bamboo and plastered on either side. The bamboo hurdle effectively re-inforces the concrete plastering [6]. This second style of building produces a result which is more culturally familiar in many countries and possibly therefore more acceptable.

### *Bamboo cultivation as a craft industry*

Thus a picture emerges of a crop that can be grown by small farmers, providing an income from land which has no other immediate use and which they can harvest and sell by themselves.

Such a landscape and industrial system has existed in the past when cloth was made by craft industry. Toynbee [17] quotes Defoe as saying that the land near Halifax (England) in 1700 was 'divided into small Enclosures from two Acres to six or seven each, seldom more, every three or four Pieces of Land had an House belonging to them; . . . hardly an House standing out of a Speaking distance from another; . . . we could see at every House a Tenter, and on almost every Tenter a piece of Cloth or Kersie or Shaloon . . . Every clothier keeps one horse, at least, to carry his Manufactures to the Market; and every one, generally, keeps a Cow or two or more for his Family. By this means the small Pieces of enclosed Land about each house are occupied, for they scarce sow Corn enough to feed their Poultry . . . The houses are full of lusty Fellows, some at the Dye-vat, some at the looms, others dressing

the Cloths; the women and children carding or spinning; being all employed from the youngest to the oldest . . . . Not a Beggar to be seen nor an idle person'.

A similar kind of landscape exists now in Zhejiang, China. Bamboo production is carried out on many small farms whose farmers now enjoy a much improved standard of living. Zhejiang is now home to more than 2000 enterprises engaged in the production of bamboo boards, floors, mats, and arts and crafts, and other bamboo-related high value-added items. Anji County in Zhejiang, China's largest grower of bamboo for commercial use, has set up more than 1200 bamboo-processing enterprises in recent years, with a total output value of 1.6 billion yuan (nearly 200 million US dollars) annually.

The craft system of production was destroyed for cloth-making by the early Industrial Revolution. Unfortunately for those people, it proved easily possible to mechanise the production of cloth and their craft passed into large factories. The factories undercut them for price and destroyed their trade.

This could be the case with bamboo too. Large scale industry could replicate with bamboo cultivation, the undesirable characteristics of blanket tree afforestation. It has been claimed that with the Phoenix bamboo-paper mill in Thailand, that is what happened (unverified internet report). In that case, it was further claimed that local people were driven off their land to make way for bamboo plantations. Large factories could replace the craft industries. However, it does not appear to be as easy to totally mechanise bamboo product fabrication as it was for cotton and wool. Moreover, the range of products made from bamboo is much greater than the simple uniformity of cotton cloth.

It is the contention of this paper that this concentration need not happen and that there are certain characteristics of bamboo which make a more participatory, distributed, model easily possible.

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