American Bamboo Society
Newsletter

Vol. 20 No. 1 **750 Krumkill Road, Albany, NY 12203-5976**
February 1999

Bamboo: Past – Present - Future

by Dr. Walter Liese, from his paper presented at the International Bamboo Congress, Costa Rica

Bamboo, its past, present and future is the topic given to this first presentation. As most of you know, I am a researcher with practical interest for applying results. Consequently, my store for such a demanding overview is necessarily restricted with limited input on management, processing and economy. My own past with bamboo reaches back to 1951, when timber shortage forced us to try bamboo culms as pit props in the coal mining industry. Having this exotic material at hand, I played around with one of the few electron microscopes, and the first electron micrographs of the bamboo ultrastructure came out 48 years ago. Considering the time span since then, one can state those experiences and also expectations regarding the contribution of bamboo for sustainable development became substantial and far-reaching. Nearly 2,000 papers on the many aspects were published during these decades.

In the following I will not present a well-balanced evaluation of the 's past, present and future of bamboo - which would take a long time - but more a personal view from obtained experiences, hereby purposely neglecting some important areas, as you may expect of a retired professor.

Past

Beginning with the pre-past, long before Adam and Eve, I want to state, that bamboo existed naturally also in Europe, some three rnillion years ago in the Tertiar (Leffond 1996) but vanished due to the ice age. Bamboo has been traditionally utilized in rural lire for ages, especially in Asia. Relics from bamboo mats and baskets were dated at the Younger Stone Age (3,300-2,800 BC) (Ding 1996). Closer scientific investigations began only about 100 years ago, mainly by botanists from Europe, like v. Mohl (1845), Munro (1868), Schwendener (1874), de Bary (1877), Camus (1913), followed by substantial contributions in Asia, as by Brandis (1874), Kurz (1876), Gamble (1888), Riviere 1879, Shibata (1900), Takenouchi (1931), later by Ueda, as well as Fairchild and McClure in the United States.

However, science and application stayed apart for a long time. The need to exchange results and to advise on better management and utilization was limited by the meagre communication facilities and concemed only certain fields of apparent needs like plant exchange, propagation, handicraft or preservation. Stronger attention towards bamboo developed with the awareness that this plant is a most valuable natural material, in view of the diminishing resources, supported also by the better contact possibilities between scientists from different countries. Thus, only at the 16th World Congress of the International Union of Forest Research Organizations (IUFRO) 1976 in Oslo, the first intemational working group of bamboo researchers was established under Prof. T. Higuchi, University of Kyoto. A breakthrough however, occurred in 1980, when the International

Development and Research Centre (IDRC), Canada, organized a workshop in Singapore on "Bamboo Research in Asia," where most of the regional bamboo specialists from fourteen countries met for the first time.
During these last twenty years bamboo development blossomed up like an explosion, as expectations, activities and achievements. Following the 17th IUFRO Congress 1981 in Kyoto, about ten international conferences were held and many more regional and national ones with hundreds of papers. Bamboo societies have been founded and bamboo joumals sprouted in many countries, such as China, Japan, India, United States, Belgium, Germany, and Switzerland. Also Bamboo Information Centres were established in China and India. Bamboo has built many bridges across the world, like the logo of the Minamata Conference 1992 has been. Nowadays bamboo also has its firm place on the internet, with an overflow of information.

Many of these activities only exist because there is a strong engine behind, supplied with considerable fuel. the Canadian IDRC, which profiled to INBAR (International Network for Bamboo and Rattan) 1991 as an inter-governmental non-profit research and development organisation. Just one year ago, November 1997, INBAR became the first international entity to be headquartered in the mainland of China, underlying the importance and appreciation of bamboo in China and INBAR likewise. I take this opportunity to express the thanks of many to Dr. Cherla Sastry, Director-General. to Dr. Ramanuja Rao, Principal Scientist, and to their colleagues for the great support given to the development of bamboo (and also rattan). INBAR, among many more activities, has summarized and promoted current knowledge in the form of valuable Technical Reports and Working Papers, about genetic variation and enhancement, priority species, vegetative propagation, equipment for processing, preservation techniques, strength-testing, panel boards, constructions of bamboo socio-economics as well as marketing studies. A number of other International Organizations have joined in promoting bamboo, like the International Foundation for Agriculture Research (IFAR), IUFRO, ITTO. the United Nations Development Program (UNDP), IBA, the European Commission (EC) as well as several national ones.

Overlooking the resulting situation, we can state that the appreciation, management, handling and utilization of bamboo is blooming. In *senso strictu*, however, the real blooming and subsequent dying of the most popular bamboo in Europe, *Fargesia murieliae,* has led to considerable disappointment from the many bamboo lovers and landscape gardeners. But the great public attention in the media to this phenomenon resulted in a boom for the bamboo trade, whereby the former genotype of *F. murieliae* is being replaced by a new generation with many superior genotypes. In Thailand the recent blooming of *Dendrocalamus asper* on about 40,000 hectares created a catastrophe for the many farmers whose only cash crop were shoots. Nevertheless, the flowering taught the lesson to design plantations with different genotypes.
Generally speaking, bamboo has found its recognized place in science, land-use management and public appreciation. Let me list only a few examples of recent socio-economical and ecological impacts of bamboo utilization:

At this very place, the National Bamboo Project of Costa Rica with the FUNBAMBU has to be mentioned first. As we will learn later it is a most impressive operation for che constuction of up to 1,000 bamboo houses annually, with material coming only from the established 60 hectare *Guadua* plantations, equivalent to the timber from 500 hectares of valuable tropical forest. These achievements helped to overcome the psychological barrier against bamboo for construction. In other parts of Latin-America, like in Colombia, bamboo is well established and the spectacular constructions by Simon Velez are based on the public appreciation of bamboo as their material.
Many of us participared in 1995 in the spectacular 6th Inrernational Bamboo Congress in Ubud, Bali, based on che inspiration and devotion of Linda Garland and her inspired team. The great expectations raised by the associated Environmental Bamboo Foundation (EBF) could in the following hardly be realized, wirh the lesson, that considerable technical and financial resources as

well as marketing are necessary for undertaking any extended program. It is gratifying to mention now, that the EBF is presently engaged in several projecrs, on soil rehabilitation and reclamation, community development and agroforestry. Furthermore, a simple preservation system against beetle attack, a Vertical Soak Diffusion (VSD), has been developed for further testing (EBF 1998).

The processing of bamboo has resulted in a larger number of versatile products with great benefits. To mention only a few: the development of bamboo-mat boards (BMB) in India with an intended production of 200,000 m3 would save the wood from 8,000 ha forest. Bamboo mat boards are used for doors, walls, fruit boxes, even for grain-store bins. A new generation of panel products are now being developed and are partly on the market, like parricle and fibre boards, oriented strand boards and beams (OBS), wafer-boards, laminated bamboo lumber (LBL) with superior bending strength (Lee et al. 1996), bamboo-cement composites and bamboo Zephyr boards, consisting of crushed bamboo stripes into thin sheets (Hashim et al. 1998, Shibusawa 1998). As a special type of natural fibre composites, the bamboo surfboards may be mentioned, which have been in use for two years. These bamboo fibre-epoxy composites have a superior strength, simultaneously showing the structural beauty of bamboo (Young 1997). Bamboo composites are developed using the excellent strength of the single fibre bundles. As much as these various developmenrs are exciting and encouraging for bamboo utilization, they will nevertheless be applicable mostly in niches, which still have to be developed further. A wider application in Europe and North America has been gained by bamboo parquet, althou~h che growing demand has (ed partially to lower qualiti~s and an over-exploitation in the regions of production.

Also considerable research on fundamental properties has been done during these years. Let me mention just an example from our work. A bamboo culm develops its tissue faster than any other plant, within only a few months. The plant has then to depend on its structural efficiency for a decade or longer, without a system for restoration, like trees have with their cambium. To safeguard the life-securing transport of water and assimilates, any damage has to be perfectly sealed off. It is remarkable to realize, how efficient the protective system of a bamboo plant functions, as by blocking off the transport channels and strengthening che cell walls. Even ten years old culms store plenty of energy in the form of starch granules to react against wounding. Such closure of the vessels as water-pathways will likewise effect the permeability for drying and preservation of a harvested culm. The so-called maturation of a bamboo culm is indicative for its utilization. It is considered to take 1-2 years, but closer investigations revealed, that celi wall thickening occurs even up to 7 and 12 years, thus influencing culm properties (Liese, Weiner 1997)...

When considering bamboo products, mainly the culm timber is thought of. This situation is partly changing, since shoot production can be more profitable, as experiences in China with a production of 15 to/ plus 300 culms y/ha have shown. Its overall value is already one third of the culm's profit. The shoot growing in Australia, with its reversed season for an intended export to Japan, shows the possible valorisation of bamboo in niches (Cusak 1998). However the production of shoots in Italy, for the J apanese market in Germany, suffered logistical difficulties.

Present

The second part, the present situation, may be defined as only this years' activities. They are mirrored best in the present International Bamboo Congress and its accompanying Bamboo Workshop with nearly 150 announced papers covering a very large range of topics and about 350 participants. Many more would have liked to come, but financing has always been a problem far the bambuseros from less-developed countries, but also for those from the more industrialized ones. The congress papers reflect widely the ongoing activities, but during the present year many more

actions for bamboo promotion have to be mentioned. INBAR has organized three regional expert consultations, for Latin-America, Asia and Africa, to also increase the appreciation and utilization in those countries, where bamboo knowledge is much in demand. Bamboo activists and decision-makers came together for developing strategies and programs. The European Bamboo Society, consisting of eight countries, held their annual meeting in Switzerland. Last month an International Training Course on bamboo cultivation and utilization took piace at the Research Institute for Subtropical Forestry, CAF, at Fuyang, organized by Prof. Fu Maoyi. At the end of this week the American Bamboo Society will have its Annual Meeting at Orlando, Florida. The following week a full day seminar on "The Future of Bamboo in Hawaii" is foreseen on the Big Island as an educational exercise to consider the possibilities of bamboo as a supplement for the fading sugar cane business. It is a follow-up of last years' event on "Design and Building with Bamboo" with Jules Janssen.

Even the European Community in Brussels became active in bamboo promotion. Currently two projects are being undertaken.

The Project "Sustainable Management and Quality Improvement of Bamboo and Products" aims to increase knowledge on the sustainable supply, use and quality improvement of selected species of bamboo in Southeast Asia in a cooperation between some regional institutions and European partners. Bamboo products of high quality, produced sustainably, have a good potential for export success in markets such as the European Community.

The other Project "Bamboo for Europe" is based entirely on a European cooperation. It intends to integrate the experience built up in Asia, with results obtained in the USA and the technological advance in Europe. The project consists of two main parts, one on propagation, silvicultural and harvesting methodologies, and one on transformation of the bamboo biomass in industry. Added values from bamboos growing in South Europe for rural development on marginal land could be soil stabilisation, riparian improvement, shelter belts and poles for fruit trees and vineyards.

In view of all these encouraging prospects a few comments should also be made on retarding tendencies. The increased use of bamboo and its products has already shown certain negative developments. In some places farmers, convinced about the profits from bamboo planting, devoted their land for several years and are asking now, how to use the many culms, where is the caIcuIated profit? There might be a lack of processing facilities or a market for bamboo products may not exists.

But mostly the situation is contradictory. Bamboo is in great demand, so that culms of inferior quality may be harvested or, even worse, younger ones through which the production capacity of the bamboo stand will decrease. There are wood mills in Asia which have recently changed from timber parquet to bamboo parquet but had to close down the production line, because of lower culm quality and increasing prices. In regions with high wages, the management and utilization of their bamboo forest becomes costly, so that the material is imported from neighbouring areas, thus increasing their shortages of bamboo culms. In certain parts of China bamboo has already become more expensive than timber with severe consequences for the bamboo industry. This is quite in contrast to the recent ITTO-supported Chinese National Program "Bamboo as Substitute to Tropical Timber"…

Bamboo cuIms and the processing have their price. The wide-spread use of bamboo products in countries of origin and abroad is mainly based on minimal wages for the poorest. This situation will slowly change towards their better living, raising simultaneously the costs for bamboo harvesting and processing. Already now a displacement of bamboo by competitive materials is to be observed. "Plastic bamboo" is produced as an "original imitation." On La Reunion, imported, nice looking bamboo walls made from plastic are less expensive than the original local ones, in Japan, even the specialist has to touch the fence to identify its true nature. In India, chairs from bamboo and plastic

are exhibited together, the plastic ones are colorful and durable with a guarantee at a comparative price. In China, in the county of Anji at the centre of bamboo production, bamboo furniture is mixed with plastic components. The former saying "bamboo is the poor man's timber" has already changed in certain parts into "only the rich can afford real bamboo," which leads now to the third and final part, the future of bamboo.

Future

Although we might be more clear-sighted after the conference than at this opening, I will give a few remarks on further developments. What might be the future of bamboo and its utilization?
Bamboo as a plant and as a product has widely increased its recognition for a sustainable development, both in countries of origin and in many others. Howeve,. there are still some restrictions, like by traditional minded administrators, who consider bamboo as a wild growing forest component or as a weed. There are also unpleasant experiences, like in Australia where the running *Phyllostachys aurea* with its uncontrolling spread is wrongly regarded as a pest, or like in Hamburg, where recently 400,000 imported bamboo candlesticks showed heavy beetle infestation. Better information and proper processing are needed for the growing trade, not to mention the about fifty million bamboo poles imported annually from Asia to Europe, mainly for plant supports.

The benefits of monopodial bamboos for soil stabilization are well known. These effects will the in future be more utilized, like in the great afforestation program with bamboo in China as a consequence of the recent flood disaster. Also by selecting salt-tolerant species large areas at the seacoast could be covered and made productive. China alone has about 2.1 million hectares of wasteland along the coast, which extends year by year 1-2 km towards the sea. Tree species with their deep rooting system hardly grow, whereas the bamboo rhizome extends horizontally within a 20-40 cm depth, so that the highly salty underwater does not affect their development. Some bamboo can grow even in wet lands, since their rhizome has well-developed air-canals (Ding et al. 1993). The identification of RAPD (Random Amplified Polymorphic DNA) molecular markers related to salt tolerance will be significant for the selection of salt-tolerant bamboos (Ding 1998). Aiso in Germany, soil stabilization along rivers and the coast-line is now considered. Bamboo has shown great benefits for water and soil conservation as well as for the establishment of shelter-belt forest in combination with deciduous broad- leaved-mixed forest, which merits further application. More knowledge is needed on the moisture requirements of bamboo species and genotypes and its seasonal demand.

The role of bamboo in our natural habitat is emphasised by its tremendous growth and the subsequent CO2 fixation. Thus, bamboo is often considered as the biggest producer of biomass. The rapid growth of a single culm, like that of *Dendrocalamus giganteus* or *Guadua angustifolia,* is indeed most impressive, but after three months no further increment takes place. In addition, the biomass of the growing culm results not from an original production with a corresponding uptake of CO2, but is based on the conversion of energy, which has been produced earlier in the older culms and partly stored in the rhizome and the connected culms. In contrast, plantations of fast-growing trees - like Albizzia, Eucalypt, or Pine - also produce a large biomass, by their own photosynthesis and nearly year round, and their stem contains more fibres than a bamboo culm which is only 40%. In che promotion efforts of bamboo we have to be careful not to exaggerate our bamboo belief. If proven only partly unrealistic we may cause much harm and discourage the needed development of the bamboo resource.

There is a staggering recorded bamboo yield of 37 ton/ha/y (Fu Maoyi 1996), but there are also reports about Eucalypt clones with a yield of 70 ton/ha/y (Brandao, 1984). Our knowledge on che photosynthetic capacity of bamboo and its efficient use of solar energy is still low. It appears

symptomatic, that for the planned topic at this Congress "Bamboo as Carbon Fixer" no contribution is given. Comparative investigations are much in need.

Taxonomy, as well as intra- and inter- specific differentiation has reached a new dimension with the rapid application of sophisticated biotechnological methods for bamboo. The use of molecular markers identifies precisely any genotype and phenotype. Thus, with the RAPD technique some taxonomic questions of the genus *Phyllostachys* have already been clarified (Gielis et al. 1997; Ding 1998). Many applications will follow, such as the measurement and maintenance of the genetic diversity and natural variability. Morphological superior bamboo genotypes can now be identified and easily multiplied by mass scale micropropagation with a capacity by one company of up to three million plants per year (Gielis and Oprins 1998). To improve the bamboo quality from the natural wild growth by the selection of superior strains is one of the prime goals with great benefits.

The leaves of a bamboo plant are generally left at the site for recycling some nutrients, or they serve as fodder in case of need. However, they also contain a larger amount of biochemical components and have been used for a long time in traditional Chinese medicine. Recent biochemical studies have revealed flavonoids and other valuable compounds with anti-oxydant activities of significance for human health, as they enhance vitality and lower blood lipids (Zhang 1997). Besides, leaf extracts are already additives to a number of health products, and the delicious Bamboo Beer is not the least one. Higher spirits and faster effects without technological processing are being obtained in Tanzania from *Oxythenanthera braunii* by collecting the bamboo sap and its subsequent fermentation to a tasty and also powerful wine. One young culm yields about ten liters (Lipangile 1998). The biochemical conversion of bamboo is an area of great promise with a considerable increase of its value.

As a quite different prospect for chemicai modification the conversion of bamboo to energy should be mentioned, being part of an EC Project. Plant biomass can be converted into charcoal, gas and bio-oil by a thermal decomposition, called flash-pyrolysis. Bamboo with its high caloric value and a relatively low ash content has the potential as an energy cash crop in a susrainable agricultural farming system. Experiments have revealed 57% bio-oil, 22% charcoal, and 21 % gas. The bamboo bio-oil has certain advantages against the classical mineral oil and could serve as a chemical food-stock (El Bassam et al. 1998). In the other EC Project the resistance of bamboo against deterioration, much influencing its utilization, is experimented on by a heat treatment at 180-2600 as a mild pyrolosis to enhance biological durability and dimensional stability (Peek and Leithoff 1998).

Bamboo timber will be used for simple and also for advanced quality structures, as a bamboo dome is being planned for the EXPO 2000 in Hannover and the bamboo-aero-plane by M. Abadie at this congress will show.

Conclusions

Finally, some conclusions and presumptions should be made. I am far from giving recommendations, which often remain lifeless. There are too many, formulated with great efforts, but hardly ever read, or even considered. Just remember the past Bali Congress with 70 papers and 45 recommendations and their real effects!

- Bamboo as a plant will gain wider application for soil stabilization and shelter forest, with proper selection of suitable species and genotypes.

- Bamboo shoots will gain further markets and will partly exceed the value of the bamboo-timber. The export of fresh high-quality shoots from the Southern Hemisphere, to off-season northern countries will add a new dimension.
- Improved management of wild stands and plantations will increase yield in quality and quantity

- Biotechnology will foster genotype selection and quality improvement of bamboo plantations

- More fundamental research will yield big dividends. Research on basic properties and processing will lead to better manipulation, improved utilization and value-added quality products. We are far from understanding bamboo's intelligence to develop in the shortest time structures, which function for a long time

- The small-scale bamboo craft industry has a vital rate for employment opportunities of rural communities, but lack of management skills, quality control, and capital prevail

- Bamboo products must be market-oriented. The competition with the more versatile plastic imitations will increase

- The vast amount of information has to be focussed for the bamboo farmer, the processor, the mill operator, the trade, but most of all for the end-user, the consumer who should choose for his money bamboo products among other alternatives. The on-going work for a Bamboo Identification Manual and a regular International Bamboo Journal need our support

- A stronger cooperation and information exchange will be beneficial. Competition in industry and commerce is common, but the acceptance of bamboo may suffer from rivalry

Bamboo contributes to the existence of well over a billion people, mostly in the poor rural areas. Only because the wages of these peoples are low, bamboo is reasonable for others. Our obligation to improve the poor man's life quality will evenly effect the availability of bamboo to others. Reviewing the furure of bamboo, Milo Clark (1997) differentiated four areas, emphasising bamboo as a horticultural plant, as an essential community resource and a local source of income, but warning to overestimate the benefits from bamboo as an industrial resource. Material supply, processing of quality products and market opportunities are essential. The bamboo we grow has to be utilized by and for the people with their environment.

May this congress be a milestone in our efforts to improve information, cooperation and understanding for the sake of bamboo, providing equally a realistic view about future possibilities, marketing opportunities as well as the limitations. And may the reality be so stable as the world's largest towers, the Petronas Twin Towers in Kuala Lumpur, which resemble with their 421 meter height, impressively expanding bamboo shoots.

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(10.1.1999)

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