Desk Copy

$20-

BAMBOO AND THE PACIFIC NORTHWEST

PROCEEDINGS OF 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

GOLD BEACH, OREGON, USA

COVER PHOTOS:

****

From top left to right:

1. Future sight in Pacific Northwest? Truck loaded with Moso bamboo in China.
2. Specimen bamboo plants ready to ship from Oregon to Los Angeles.
3. Inadomi Moso bamboo grove in Northern California.
4. Moso bamboo grove on a thin layer of mountain topsoil at Mt. Mogan, China.
5. Born in Northern California and grown up in Hawaii, Gary Young's Wooden Classics Hawaii surfboard and sailboard hulls made with structural layers of bamboo veneer. Unfinished hull overlaid on photo of bamboo veneer sheets.

Photo credits:

1 - 4 by Gib Cooper
5 and overlay by Gary Young

****

The Proceedings of the Pacific Northwest Bamboo Agro-forestry Workshop

Edited by Gib Cooper
Co-edited by Tom Taylor
Produced by the Pacific Northwest Chapter of the American Bamboo Society
Second printing in January 1998 by Lakewood Printing, 6111 Steilacoom Blvd S.W., Lakewood, Washington 98499 in the United States of America

Addresses:

The American Bamboo Society
750 Krumkill Rd.
Albany, NY 12203-5976

The Pacific Northwest Chapter of the ABS
Dean Hines
15211 - 91st Ave SE
Snohomish, WA. 98296

The Northern California Chapter of the ABS
David King
480 West "I" St
Benicia, CA 94510

American Bamboo Society
Bamboo Collector
Pacific Northwest Chapter

Second Printing published by Pacific Northwest Bamboo Press
January, 1998

TABLE OF CONTENTS

1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

On June 24-25, 1994 one hundred bamboo professionals and enthusiasts convened in Gold Beach, Oregon to focus on the future of the fledgling bamboo industry in the region.

The participants listened to a day of presentations by a series of speakers. The presentations were as follows:

American Bamboo Industry - Past, Present & Future: Comparison/Contrast to China. Presented by Gib Cooper.

Agro - Forestry Uses for Bamboo in the Pacific Northwest. Presented by Karl Bareis.

Northwest Experiences in Bamboo Agro-Forestry. Presented by Rick Valley.

Bamboo on the Farm. Presented by Daphne Lewis.

Research Program for Bamboo Pulp and Paper Production. Presented by Daryl Ehrensing.

Timber Bamboo. Presented By Richard Haubrich, founding president of the American Bamboo Society (ABS).

Development of a Bamboo Plantation in Vietnam. Presented by Simon Henderson.

As part of the workshop there was a mini-tradeshow along the side areas of the hall. Displays were set up by bamboo nurseries, a bamboo importer, and a harvester of fresh bamboo shoots and poles.

On the final day of the workshop a lively brainstorming session was facilitated by Daryl Ehrensing, of Oregon State University, Corvallis, Oregon. The group set out to prioritize goals and develop a strategy for accomplishment, to appoint responsible group chairs, and to set date, and location of the next workshop. After three hours of vigorous brainstorming by the group, a list of seven goals was developed and responsible groups were formed.

The projects listed as most important and possible to accomplish are as follows:

1. **Municipal sewage applications**

   In many areas municipalities use spray irrigation over large fields for final disposition of sewage waste. An experimental bamboo plantation using one of these facilities was proposed.

This method of handling sewage waste water appears to have hayfields or golf courses as the main recipients. Hybrid poplars have also been growing under these experimental conditions.

2. **Riparian improvement**

Many streams and rivers in the Pacific Northwest are affected by logging, livestock, and other human activities. Natural resource agencies and private landowners are revegetating miles of these disturbed water courses. On public lands the goal is to replant the areas with native species. Some landowners want to replant private riparian areas with bamboo. Bamboo would create a beneficial environment for aquatic life by cooling the water with shade and providing food for fish. A strip of bamboo alongside a stream would buffer the riparian zone from cattle and other livestock. Bamboo rhizomes knit and hold the fragile stream bank soils from flooding and erosion. Landowners would be growing a marketable crop of bamboo poles, plants and bamboo shoots.

3. **Survey of interest in computer networking**

There is an important need to promote communications between people working with bamboo worldwide. A proposed method for accomplishing this goal is through information networking via computer telecommunications.

Before the international bamboo community can be interconnected a suitable communications path must be chosen that is accessible to all. The chosen vehicle to make this decision is an international survey of all the institutions and individuals creating bamboo information for dissemination.

Funding for the project could be requested from the world bamboo societies and institutions involved.

4. **Determination of target species for pulp, poles, shoots, and craft applications**

American bamboo growing is in its infancy. More knowledge is needed concerning the best bamboo species to grow for various purposes in the variety of climates found in the Pacific Northwest. It was proposed that coordinated research efforts be undertaken through literature searches and test cropping as many species as possible.

5. **Proceedings of the workshop**

The compilation of the papers and the group discussion period of the Pacific Northwest Bamboo Agro-Forestry Workshop is to be published.

6. **Development of other goals for researchers**

As bamboo growing progresses in the U.S.A., new information will

be needed. The bamboo agro-forestry group will have to determine research goals and funding sources. Cooperation and communications between institutions and individuals will be a most important facet any project.

7. **Formation of grower, cottage industry and marketing coops**

A sizable number of the participants of the bamboo workshop represented people working in the region's bamboo trades. The group as a whole felt the need to organize efforts in specialty areas.

Bamboo growers with nurseries felt more cooperation would be beneficial to consumers. Supply and demand problems could be tackled on a group basis as a trade association.

Bamboo crafters need to be more organized to broaden the market. A larger market and variety of products could be made available to consumers.

Producers of bamboo poles, shoots and fiber need marketing coops to amass commercial quantities for manufacturers and distributors.

The 1994 Pacific Northwest Bamboo Agro-Forestry Workshop was coordinated by Gib Cooper.

Funding for the workshop was provided by:
The Promotion Committee, Gold Beach Chamber of Commerce
The Pacific NW Chapter of the American Bamboo Society
Oregon State University Extension Office

The 1997 Pacific Northwest Bamboo Agro-Forestry Workshop has been scheduled for June 21-22, 1997 at Centralia College, Washington.

For further communication contact:

Gib Cooper, Coordinator PNW Bamboo Agro-Forestry Workshop
28446 Hunter Creek Loop
Gold Beach, OR 97444
Tel. or FAX 541/247-0835 e-mail: bambugib@harborside.com

ACKNOWLEDGEMENTS

100 Attend Pacific NW Bamboo Agro-forestry Workshop in Gold Beach, Oregon

PRESS RELEASE by Gib Cooper June 27, 1994

The workshop last weekend at Docia Sweet Hall drew lovers of bamboo from all over the west. The big hall was perfect for the presentations by experts on practical applications of bamboo for wood substitutes, paper pulp, hedges, food, ornamental plants, and a thousand other uses. Participants listened to Gib Cooper's historical report on bamboo in the USA and China, Rick Valley's experiences with bamboo in permaculture applications, Daphne Lewis's enthusiastic landscapes with bamboo having a place on every farm, Karl Bareis's wonderful expedition to Yunnan Province, China and the similarity of plant species that are only found there and the Pacific Northwest, and Daryl Ehrensing's excellent survey into the details of alternative fibers available for paper pulp. The program included the additional speakers, Richard Haubrich, founding president of the American Bamboo Society (ABS) and Simon Henderson, a permaculturist recently returned from a start up bamboo plantation in Vietnam.

The information starved audience was lured away from their favorite subject by the arrival of a carload of pizza and salad from Whitewater pizza. The group polished off 25 pizzas, socialized and resumed listening to presentations until well into the evening.

On display were bamboo plants, bamboo poles, fresh bamboo shoots, special tools for cultivating or harvesting bamboo, catalogs from bamboo nurseries, books, bamboo board flooring and gift items. Knowledgeable people attended each display. There was much to learn.

On Sunday morning, over two-thirds of the group returned and started with pastries from the Taylor family bakery and good coffee donated by 1st

Impressions owners Kathy and Scott Brace. More good comments were received from the group about the tasty food service.

The work session that followed was moderated by OSU-Corvallis Research Assistant, Daryl Ehrensing. Topics covered bamboo growing, the many species of bamboo (over 1,200), uses for bamboo as a marketable product, research needs and field testing, market and financial analysis, China and bamboo, and the formation of the national and international bamboo information network.

After three hours of vigorous brainstorming by the group, a list of seven goals were developed and assigned responsible groups. The projects include: municipal sewage applications, riparian improvement, survey of interest in computer networking, determination of target species for pulp, poles, shoots, and craft applications, proceedings of the workshop, development of other goals for researchers, and formation of grower, cottage industry and marketing coops.

The group briskly moved through the work so the plant sale could have more time. Dr. Don Emenhiser, the president of the Pacific NW Chapter of the ABS, managed the sale of plants brought in by bamboo nurseries. The rarest of the plants were auctioned off. One beauty went for $80. Auctioneer Ned Jaquith of Portland was assisted by Mike Remmick and Lisa Walters.

Following the workshop, many people toured the bamboo plantings of Garold Nelson in Coquille, Tom and Susan Taylor in Brookings and Bob Warring in Port Orford.

Workshop coordinator, Gib Cooper, was pleased to see all of the prior planning fall into place to create the comfortable but business-like environment he had hoped for. He was overheard telling people, "Gold Beach is a great place to hold a mini-conference. Where else can you find facilities like this, scenery, service and 700 hotels rooms on the beach?"

"However the real reason the workshop was so successful lies in the people who worked so hard to bring it off", Cooper explained. Dan Nickel, local OSU extension agent, assisted in the planning and introduced the speakers. OSU provided the audio-visual equipment. Videographer, Maureen Walker, did a

topnotch job of taping the complete proceedings, as did Herb Hillery from Dallas, Texas (our award winner for total miles traveled). Herb is the manager of the ABS bookstore and wanted the tape to present to the Texas chapter.

Ann Chapman coordinated the registration desk and the food service. Thanks to Susan Taylor, Mary Stansall, Laura Feeter, Maureen O'Connor and Susan Mathison for their super job. Tom Taylor did a commendable job, not only coordinating the after workshop tours but anticipating every need during the progress of the activities.

The staff at the Curry County Fairgrounds and the Gold Beach Chamber of Commerce deserve commendation for another job well done.

topnotch job of taping the complete proceedings, as did Herb Hillery from Dallas, Texas (our award winner for total miles traveled). Herb is the manager of the ABS bookstore and wanted the tape to present to the Texas chapter.

Ann Chapman coordinated the registration desk and the food service. Thanks to Susan Taylor, Mary Stansall, Laura Feeter, Maureen O'Connor and Susan Mathison for their super job. Tom Taylor did a commendable job, not only coordinating the after workshop tours but anticipating every need during the progress of the activities.

The staff at the Curry County Fairgrounds and the Gold Beach Chamber of Commerce deserve commendation for another job well done.

EDITOR'S NOTE

The time that has passed since the 1994 Pacific Northwest Bamboo Agroforestry Workshop has seen some progress made to the goals. In this time, the first Professional Bamboo Growers Conference was held prior to the American Bamboo Society's annual meeting in Savannah, GA. Linda Garland reported that the International Bamboo Festival held in Ubud, Bali in 1995 had more than 2,900 participants. The Big Island Bamboo Conference has been planned for Hilo, HI in 1996. Interest in bamboo is certainly on the rise.

The brainstorming session at the first Pacific Northwest Workshop in 1994 resulted in seven goals important to the advancement of the bamboo industry in the region. The list was a working outline for this "grass roots" symposium and was not prioritized. Progress in any one of the goal areas is the result of someone taking responsibility for getting the job done.

I would like to portray some of the projects and people behind this progress in the last few months.

Barney Amdahl's place is a narrow couple of acres along 1/2 mile of the Coquille River near Oregon's coast. He keeps some livestock in fields adjacent to the river. The State of Oregon has a riparian improvement program that assists landowners in reestablishing plants along the riverbank. If an application is approved, the state will plant and fence the applicants property with native waterside tress like willows and alders. Barney was able to use the program to plant 3 species of bamboo. He had to purchase the bamboo himself but the State did the rest.

Jim Ryan of Santa Cruz, CA is another champion of bamboo progress. Jim is the head of campus housing at the University of California at Santa Cruz. He was able to get approval to use the computer system for managing the e-mail list for bamboo. There are about one hundred bamboo researchers, growers,

crafters and just interested people that have joined the list and participate in international discussion on our favorite grass. To join the bamboo group send an e-mail message to <Maiser@housing.ucsc.edu> with the message: subscribe bamboo.

Barry Abrahamson is a computer specialist from Washington. He and his son, Peter, volunteered to to design and present the American Bamboo Society's home page on the World Wide Web. The site can be accessed by anyone using the Internet. Thousands of people have visited the bamboo web site. The address (URL) is <http://www.halcyon.com/p1rabbit/bamboo/abs.html>.

Other "bambuseros" (a word coined for American bamboo lovers) have been working to increase cooperation amongst the bamboo professionals in this country. Adam Turtle has been diligently publishing the "Temperate Bamboo Quarterly" , coordinating workshops and conferences. Daphne Lewis and her partners, Simon Henderson and Stuart Brune are consulting with farmers interested in planting acreage of bamboo. Their activities are helping to from cooperation between bamboo suppliers in the region.

Interest by agricultural research professionals like Daryl Ehrensing of OSU and Dr. Carol Miles of WSU may help pave the way for more acceptance of bamboo as a crop worthy for further evaluation and the development of markets and management systems.

These proceedings, the compilation of the presentations at the workshop, were prepared for me by the speakers. The papers were edited and drafted into this manuscript. Tom Taylor of Brookings, OR was the second editor. His work was drafted into the final version. Ned Jaquith and Rick Valley performed the final read and last editorial contributions.

The officers and volunteers of the Pacific Northwest Chapter of the American Bamboo Society must be recognized for their labor in all aspects of promoting bamboo to the public. People like former president, Dr. Don Emenhiser, current president, Ned Jaquith and newsletter editor, Phil Davidson. Without their help this chapter would not have grown to be the largest in the country. Their devotion to bamboo has permitted the publishing of this manuscript and

continuation of the bamboo workshops as a project of the chapter.

I hope you enjoy the diversity of the individual presentations. Please remember this motto gleaned from the Russian River Stump, a Sonoma County, CA alternative newspaper: "Perserverence Furthers".

Gib Cooper
Editor

American Bamboo Industry - Past, Present & Future: Comparison/Contrast to China.

Gib Cooper
Tradewinds Bamboo Nursery
28446 Hunter Creek loop
Gold Beach, Oregon 97444

AMERICA

The South: Kudzu, & Bamboo

In the early eighteen-hundreds, American ships plied the oceans in commerce and whaling. Some New England shipping companies were in active trade with China and Asian countries. There were many articles of Chinese manufacture that were desired by Americans and the Europeans. These articles of trade included many products made from that mysterious giant grass: bamboo. Many a New England home became residence for utility items, furniture and artifacts made of bamboo. Today, some of these original imports may still be found in estate sales and on the floors of antique shops.

Oriental bamboo plants were introduced into the USA perhaps around 1865. Edward McIlhenny of Tabasco, Louisiana hot sauce fame, gathered a collection of 64 different varieties in his garden on Avery Island.

Native bamboo of the genus Arundinaria were once common along waterways from Tennessee to the Atlantic and Gulf Coasts. However, land clearing and grazing activities by settlers and farmers severely reduced the size and range of the bamboo 'cane brakes' (Arundinaria gigantea).

During the late 19th century bamboo and kudzu vine were touted as miracle plants by agronomists interested in solving problems of the poor farmers of the Southeast. Use of these plants by poor farmers in southern Appalachia could reduce soil erosion and feed cattle. Bamboo was exposed to curious Americans at the Centennial exposition. Kudzu went on to gain fame as one of the best examples of a plant introduction whose intended results were clouded by it becoming a rampant pest plant now found covering acres and acres of Southeastern America.

Asian Laborers and the West

During the Gold Rush days, gold diggers appeared in California by the droves from 1849 on. Many of these miners were Chinese and other Asian people familiar with bamboo. Most of the early Chinese immigrants came from Toishan Province (200 miles SW of Hong Kong). By the end of 1851 there were more than 25,000 Chinese in California. Between the years of 1870-1875 about 80,000 Chinese came to California. In fact, one-tenth of California's population was Chinese until the early 1880's. After the gold ran out, Chinese were used as laborers on the railroad, for levy building and farm workers. Many moved to the cities to begin today's China towns. In 1902, further immigration of Chinese ceased by signature of President Teddy Roosevelt.

Japanese immigrants came to California and Hawaii. Many became successful farmers in the rich farmlands of the Sacramento and San Joaquin valley. Until WW II, families visited freely between Japan and America.

Many of the West's finest bamboo groves can be found in the areas where Asians lived and worked in the past 100 years.

It could be said that bamboo in the USA is historically concentrated in two regions: The West coast states with Hawaii and the Southeastern states.

Dr. F. A. McClure, the USDA Introduction Station and Bamboo Research at Savannah, Georgia

In 1919, the USDA began collecting and maintaining an extensive collection of

hardy bamboo at Savannah, Georgia. This collection consisted of 70 accessions, including 21 species of Phyllostachys and 17 species of other genera.

The USDA supported research to determine the suitability of domestically adapted species for paper pulp. A variety of paper products were prepared using the Kraft and Raitt processes using bamboo alone or a combination of fibers. Results showed that any of the species studied could be used for paper making. Other researchers showed the suitability of bamboo for dissolved pulp and structural board.

In 1956, the researchers at Savannah planted bamboo acreage to compare cultural, and harvesting practices and to determine what species gave the best yield. Data were gathered after 7, 8 and 9 years.

Conclusions based on this short term research need to be carefully analyzed or reproduced. Some stated conclusions by researchers are that regrowth yields fluctuate widely from year to year, not in a good year, bad year pattern, but apparently in response to weather factors. Cold winters and adequate rainfall appear to be the most important climatic requirements at Savannah.

The best rate of increase for bamboo by division appears to be an annual doubling of the area covered. One acre of nursery 2 year olds will produce enough rhizomes and plants to establish 4 acres.

Flowering of bamboo species used for production could be potentially disastrous to the grower. For any enterprise dependent upon a source of bamboo, the diversity of that source should be a major consideration. Maximum diversity, both within species and among similar species, should be encouraged as the only known defense against loss due to flowering. Systematic means of dealing with flowering could be developed.

Dr. Floyd A. McClure, until his death in 1970 was the USA's authority on bamboo. He traveled to China as a botanical explorer for the Smithsonian Institution. He visited the area of China that grows Arundinaria amabilis-Tonkin Cane or Tea Stick Bamboo in Guangdong province.

In his handbook, Bamboos of the Genus Phyllostachys Under Cultivation in the United States, (1957, USDA Handbook #114) McClure writes about the economic importance of bamboo. "On account of their obvious potential value to agriculture and industry, and their appeal as exotic garden ornamentals, the bamboos, particularly those belonging to the genus Phyllostachys, have been the focus of absorbing interest in the United States for many years. Although a number of successful importations of living plants had been achieved by private initiative during the late eighteen hundreds, the activities of the USDA in the introduction of promising bamboos began about 1900. The first bamboo appeared in the Departments "Inventory of Plants Introduced" in 1899 under the P. I. #2903. Since that time some 750 individual bamboo introductions have appeared in the records. Of these, about 200 represent species of Phyllostachys."

McClure goes on to note that, "In China bamboos of the genus Phyllostachys have been for centuries the principle source of paper pulp, a major source of timber and handicraft materials, and an important source of that esteemed comestible, bamboo shoots. In Japan bamboos of this genus have supplied valuable items of export in the form of fishing poles and porch shades, commodities familiar everywhere in this country. This is more impressive when it is realized that, of this numerous group of bamboos, Japan has in general cultivation only four species and their variants. In the United States 24 species and 11 cultivars of Phyllostachys are now established, principally through the activities of agricultural explorers of the USDA." The Japanese species may be Phyllostachys bambusoides, P. het. pubescens, P. nigra varieties and P. aurea.

"Plants of a number of these species have been distributed for trial in various parts of the USA. A partial perspective on their future place on the farm and in the land-use patterns has been achieved, but the task of exploring the possibilities of this group of plants in the economy of the USA, especially for paper pulp and for use in water-shed protection and erosion control, remains largely untouched."

Bamboo Growing in Alabama at Auburn University

At Auburn, Alabama experiments with bamboo had been underway since 1933. Plants were introduced from several nurseries but most were from the

Savannah, GA plant introduction station.

In 1959-60 approximately a 100 acres of bamboo were planted to study the problems of production, harvesting, and use of bamboo. These experiments were initiated with the active cooperation of the New Crops Research Branch of the USDA. The discontinuation of cooperation in 1965, reportedly as an economy measure, resulted in drastic curtailment of planned harvesting research and abandonment of plans for utilization research.

It is a fact that Loblolly pine is the undisputed king of the pulp production forests of Southeastern United States. The main companies in control of this vast acreage have names like Georgia-Pacific and Louisiana Pacific.

Research production for Alabama showed some interesting results comparing 8 year old stands of Pinus taeda (Loblolly pine) and Phyllostachys bambusoides (Japanese Timber Bamboo). Yield of oven dry wood per acre was 15,870 lbs. for the pine and 27,740 lbs. for P. bambusoides. Phyllostachys rubromarginata produced almost double the dry weight of P. bambusoides. Bamboo fiber for paper pulp is better suited for some products.

Then What?

After the middle 1960's, bamboo research by the USDA seemed to have disappeared. Without facts concerning the cause of the loss of funding for this research it can only be speculated why these programs were killed with only the barest results published?

During this time, the southeastern USA went wholeheartedly into the cropping of Loblolly pine for major pulp production.

It is remarkable how Dr. F. A. McClure's earlier work with bamboo almost forty years ago is so appropriate for Americans working with bamboo in the present.

Advent of the American Bamboo Society

The American Bamboo Society was founded in San Diego, California in October, 1979. , Dr. Richard Haubrich, first president, states that the society

was founded,"to fill a vacuum in bamboo culture and research that has existed" since the government ceased large scale bamboo research in 1965.

With permission from the Quail Gardens Botanical Foundation, the founding members began to plant a collection of bamboo on the garden grounds. Dr. Haubrich traveled to the former plant introduction station at Savannah in 1980 to further the collection.

Dr. Haubrich obtained a permit in 1980 to import bamboo into the USA. A quarantine greenhouse was made available to the society on the grounds of Quail Botanical Gardens. The first imports were from collections in France and Taiwan. A two year quarantine period was required by the USDA for imported bamboo plants. Dr. Richard Haubrich, Ken Brennecke and Gilbert Voss, the curator of Quail Botanical Gardens, took special care of the plants in quarantine. The successful beginnings of the society would have to be attributed to the hard work of Dr. Haubrich and a capable group of volunteers. Many new and valuable bamboo species were imported into the USA through the efforts of these volunteers.

In the years following, the ABS experienced national growth. From 1982 to 1992 the ABS formed regional chapters in Northern California, Pacific Northwest, Caribbean, Northeast, Southern California, Southeastern Highlands, and Texas. Each chapter takes advantage of its location and regional accessibility to encourage the promotion of bamboo and participation in chapter activities.

International Cooperation

Travel and communication between bamboo enthusiasts in USA, Europe, Australia , Asia and Africa began to educate many people on the potential for bamboo as an agricultural-forestry commodity.

At the Second International Bamboo Workshop sponsored by the Chinese Academy of Forestry and the International Development & Research Centre of Canada, the way was paved for the introduction of bamboo production on a larger scale. National bamboo organizations were introduced to each other in this 1985 workshop held in Hangzhou, China with unanimous expression of

the need for a bamboo information center or service. The need was expressed to have the center serve Asia first and then the rest of the world.

After the 1985 workshop, one was convened in India in 1988 and another in Thailand in1991. The Thailand workshop was well attended by Americans representing private and societal interests. Numerous new tropical plants were introduced. Contacts were made between Americans and Chinese that eventually resulted in the 1993 Sino-American Bamboo Expedition to Yunnan.

The European Bamboo Society (EBS) was formed in 1987 on a suggestion to Wolfgang Eberts and the others preparing for the International Bamboo Congress to be held at Bambuserie Prafrance near Anduz, France in 1988. The EBS is a forum for all interests related to bamboo.

During the 2nd International Bamboo Congress held in 1988 in Prafrance, participants decided that formation of an international bamboo society was a worthy goal. The first outgrowth of this idea came from the 1991 International Bamboo Workshop held in Chiangmai, Thailand three years later. This became the International Bamboo News Exchange (IBNE) Newsletter .

In 1992, the international organization became more formalized with the drafting of the principles for a working union of bamboo societies. By early 1993, after an invitation by Karl Bareis of Santa Cruz, (one of 8 members of the organizing committee) to all known national bamboo organizations, the International Bamboo Association (IBA) was formed among the national groups of several regions. The International Bamboo Association's value can be appreciated in the transfer of information from country to country about bamboo's usefulness. More work remains to communicate new information about bamboo's unique properties to governments and potential users. The IBA is now an organization comprised of 86 member organizations and represents 35 countries around the world.

The 4th World Bamboo Congress is to be held in Ubud, Bali, Indonesia from June 1 to June 4, 1995. This will be, perhaps the largest and one of the most interesting of the meetings in the world family of bamboo.

CHINA

Prehistoric Bamboo

Vietnam cave sites yield remains of Homo erectus and Gigantopithecus in one place. Theoretical confrontation between man-ape species may have taken place in the tropical forests and bamboo groves of SE Asia. There is the tantalizing prospect that evidence may reveal Homo erectus somehow contributed to the extinction of the 12 foot tall great ape.

Bamboo may have shaped prehistoric tool making for more than 1 million years. Karst caves and other archeological sites in Southeast Asia reveal stone tools considered by many archeologists as being less "advanced" than tools found west of the region. These regions are delineated by the "Movius line". This imaginary line runs parallel to the physical barrier of the Himalayan mountain ranges. Archeologists have long pondered the significance of the differences in these stone tools.

The archeologist, Movius, considered the meaning of these types of tools to be that the Far East was a region of "cultural retardation". For years this theoretical explanation was accepted. A new hypothesis is that early Asians relied heavily on tools they made of materials other than stone. Interestingly, the "Movius line" roughly corresponds to the natural distribution of bamboo in Asia. It appears that Southeast Asia has been heavily forested for many millions of years. This is still one of the areas of dense bamboo forests remaining in the world. Man may have moved into this region from a savannah technology from Africa. Based on this new theory, bamboo was probably one of the most important raw materials used by early Asian people.

Chinese Culture and Bamboo

Chinese civilization is closely associated with bamboo. Bamboo was the inspiration behind some of China's most famous inventions. The junk, a sailing vessel, had internal bulk heads to halt flooding of the hull if the hull was damaged. This idea was borrowed from the bamboo culm and its divisioned interior. The bamboo culm with the internal divisions removed makes bamboo the perfect natural tube. This property was exploited over two thousand years ago for irrigation and natural gas wells. Even guns were made with bamboo

barrels! Bamboo gambions hold stones in bundles for dams and erosion control along waterways. Bamboo is widely used for agriculture, fishing, industry, construction, paper making, handicrafts and items of daily use.

Chinese are justly proud of their historical association with production and use of bamboo. Historically, exploitation bamboo was slowed by external aggression, interior bureaucracy, and backward economics. Since1949, the Chinese government has paid more attention to bamboo development. A 70% increase in acreage and attainment of higher yields were evident by 1985.

There are over a thousand uses for bamboo. Bamboo culm surface was used as early as 200 B.C.for inscription before the invention of paper by the Chinese. Marco Polo described the many uses of bamboo he saw in the 13th century, including the massive suspension bridge spanning the Min River in Sichuan. It consists of 7 inch split bamboo cables strung on giant capstans for proper tensioning. This bridge spanning 300 paces is still in existence!

During the Cultural Revolution there were no incentives to improve timber and bamboo supplies. This period in Chinese history resulted in merciless destruction to China's dwindling forests as population grew and the appetite for fuel and housing increased.

Today, farmers still must meet quotas but they are encouraged to grow extra crops and sell them on the private market. More bamboo is grown than ever before, both as a substitute for their dwindling timber resource and for a thousand products suited for its natural strength and beauty. These products made from bamboo can be sold in farmer's markets throughout the bamboo growing regions of China.

The Bamboo Explosion

In 1984, a national organization of bamboo workers formed the Chinese Bamboo Association. The National Economic Development Plan, designed by the central government, encouraged members of the Association to double the area of land devoted to bamboo and to increase production to four times the 1984 figure. The Association also encouraged the central government to substitute bamboo for softwood or hardwood timber. Over 100 factories were

established for manufacturing bamboo ply board, woven mat board and particle board.

Research in the silvaculture of bamboo is undertaken by the Nanjing Forestry Institute. Studies in pruning, harvesting, dual cropping, fertilizing, and processing have substantially increased production. Mechanized processing of bamboo culms has increased with new machinery.

There are 24 experimental stations for bamboo research in 10 Chinese provinces. The results of bamboo research are presented to bamboo growers in regional workshops. Results of the research are also shared with more than 200 researchers in 30 countries.

Tonkin Cane, Arundinaria amabilis, is the most known and prized bamboo overseas. Acreage increased from 17,000 to 42,000 from 1949 to 1980. Production increased from 7000 tons to 40,000 tons per year. About 5,000 tons were exported in 1980 with most going to Europe for plant stakes. The largest and best quality poles are used for split bamboo fishing rods and furniture. Many of these poles are imported to the USA.

Mao Chu, Phyllostachys heterocycla pubescens or "Hairy bamboo" (Moso-Chiku in Japanese) is China's most important bamboo today. About 2/3 of all bamboo planted in China is Mao Chu (Moso). One of the best groves of Mao Chu in China has an annual yield of 40 tons per hectare. This a from a grove that is managed using modern techniques. Groves of Mao Chu are managed one way for bamboo shoot food production and another way for bamboo culm or pole production.

Demand Exceeds Supply

Since 1985, bamboo production has doubled. The increased production is fueling an incredible economic revival. Bamboo is found everywhere. It can be grown on small farm plots and in the household garden. Many cottage industries are thriving due to the remarkable strengths and qualities of this plant. Bamboo has unusual bending strength. The quality is similar to today's man-made fibers like fiber glass and carbon fiber. The special matrix of bamboo has a fibers densely packed on the outside of the culm while they are

spaced further apart on the inside wall.

In Nanjing, the strength of bamboo has been analyzed in the laboratory. It's tensile strength has been tested at 2000 kg to the square centimeter, twice that of timber. It's compressive strength is 10% higher than timber. It's bending strength is 1500 kilos per square centimeter.

Bamboo shoots are exported to Japan where the shoots are further processed and packaged for the Japanese market. One bamboo shoot processing plant is owned by the workers who bought shares in the company. The annual production for the plant was 600 tons in 1984, 700 tons in 1985 and 1200 tons in 1986. Bamboo shoots sell well abroad. The Chinese producers hope to equip their own factories with modern equipment in order to bypass the Japanese middlemen.

As China's population swells, many new roads are being cut into the hills and mountains. Bamboo plays a role in erosion control.

A paper mill in Harbin, China depends on bamboo supplies to increase its paper production. Although paper made from wood is also produced in the same factory, wood is scarce in China. The factory is trying to buy land to increase its supply of bamboo. The price of bamboo from the farmers supplying bamboo recently doubled in one year. A shortage of paper in China has created a market for handmade paper, since manpower is in good supply but power to run factories is not always available.

Since China's forest reserves are decreasing, the government has worked hard to replace timber with bamboo. The government offers low interest loans and even grants to encourage farmers to plant bamboo. The World Bank has also recognized the importance of bamboo as a substitute for wood. It recently provided a loan to build a factory which compresses bamboo mats into ply board faced with a timber veneer. The mats are hand woven by farmers in their off season and sent to the factory where they are glue laminated together into sheets. The board without the veneer has many uses: such as roof sheathing, sub-flooring, and panel applications. The finished sheets are used in furniture and fine wood working. With help from another World Bank loan the factory intends to double its size.

There are similar stories to be found all over China. Another factory uses bamboo veneer cut from the culm by a rotary cutting tool. The bamboo is laminated on the surface of plywood. Truck factories are using bamboo ply board to form the truck bed. New products like paper faced concrete form board are of such quality as to be exported to Europe for concrete construction. Bamboo is now well established as a material appropriate to China's open policy.

Prof. Hsiung Wenyue is one of China's leaders in using their great bamboo resource in solving many problems related to timber depletion. Even in retirement, he uses his expertise to help rural farmers start bamboo workshops. He is also free to travel abroad and assists other countries to develop bamboo resources. This travel includes the USA where he graduated from college.

THE FUTURE FOR BAMBOO IN AMERICA

Lots of Land, Some Demand

The situation is different for Americans. Our European heritage has left us with no cultural basis for bamboo to be an everyday part of our lives. (It is curious to note that bamboo is not endemic in two continents: Europe and Antarctica.) Everything bamboo has been introduced to us from Asia. The goods and products made from bamboo have been admired and loved for over a century. Our forest industry has had a natural resource paradise for the housing and goods our people need. It has taken our culture a mere few hundred years to recognize that what was once viewed as a wild country with unlimited resources, as really being finite.

Our timber lands are at the point where sustained yield will have to be adequate for future Americans. Alternative sources for wood fiber must be developed. The foundation of bamboo resources has been provided by the USDA, Asian immigrants, the American Bamboo Society and the many people working at the grass root level. As we see demand for bamboo products from Asia increasing we need to focus on developing the economies of bamboo growing and processing on a larger scale.

Over the past ten years, many people in America have found the beauty and utility of bamboo. There are crafts people, makers of flutes, paper, baskets, fences and art. There are nurseries growing and selling bamboo plants to home gardeners, landscapers and farmers. There are people harvesting bamboo poles for construction and craft use. There are domestic suppliers of bamboo shoots to restaurants and markets. But there is a need for more cooperation and development in the market demand and supply.

Many of the bamboo groves that were planted years ago are in the hands of the wrong people or in disarray due to budget cuts and changed priorities. There needs to be a concerted effort to develop resources which can be maintained for production over the longer term.

There are established groves of a few species with sufficient biomass to substantially increase planted acreage. In the Pacific Northwest a few species of the Phyllostachys genus, such as aurea, aureosulcata, bambusoides, nigra 'Henon', nigra megurochiku and vivax are found in large groves in a number of areas. These groves should be used to propagate even larger plantings on the scale of a ranch or farm.

Bamboo can also be used as a management tool to separate livestock from salmon or trout streams. The bamboo would cool the water and provide nutrients and insects to sustain aquatic life. The property owner would benefit by the annual harvest of bamboo poles or shoots.

There are many new species of bamboo that have been introduced into America over the last fifteen years. Many of these were acquired by members of the American Bamboo Society. Only a few species may have enough biomass to be usable for propagating additional large scale plantings. One species that is suitable is Phyllostachys heterocycla pubescens or Moso. This bamboo is incredibly useful. Since the biomass for this species came from the large numbers of seedlings produced in the mid 1980's and with newer seedlings up and coming, the potential for this species is much greater than for a species introduced by a few plants. However, there is the problem that most Americans don't know how to begin or manage a bamboo farm, particularly, a farm started from large quantities of bamboo seedlings. Most Americans have learned from

literature and trial and error.

The other region where other species may be found in greater supply is the Southeastern quarter of America. Some bamboo species there have only recently found there way to the Northwest. Examples are Phyllostachys rubromarginata and Arundinaria amabilis.

From these earlier efforts and the continued work of people today, Americans can further the goals of advancing bamboo as an important domestic agro-forestry crop. It is important to continue to build on world wide foundation of communication and cooperation.

References

1. James, Jamie. Stalking the Giant Ape. Discover Magazine. Feb. 1989. pp. 43-50

2. Marden, L. Bamboo: the Giant Grass. National Geographic. Oct. 1980. pp. 504-528.

3. Conover, Adele. A New World Comes to Life, Discovered in a Stalk of Bamboo. Smithsonian Magazine. Oct. 1994.

4. Adamson,W. C., White,G. A., DeRigo,H. T., and Hawley, W. O.,. Bamboo Production Research at Savannah, Georgia, 1956-77. Agricultural Research Service, USDA. 1978

5. Sturkie, D.G., Brown, V. L., and Watson, W. J.,. Bamboo Growing in Alabama. Agricultural Experiment Station, Auburn University. 1968.

6. McClure, Floyd A. Bamboos of the Genus Phyllostachys Under Cultivation in the United States, USDA Handbook #114. 1957

7. Voss, Allison. Bamboo is Hardy, Versatile Plant. San Diego Evening Tribune. 11/25/1983, Pg. E-1.

8. Pope, G. G.,. Bamboo and Human Evolution. Natural History Magazine. Oct.

1989. pp. 49-56

9. Blakstad, Executive Producer. Bamboo. A Workhorse Production. Channel Four Television. 1988

10. Zhu, Shilin. Li, Weidong. Zhang, Xinping. Substitute Bamboo for Timber in China. Institute of Scientific and Technological Information, Chinese Academy of Forestry. May 1994.

Bamboo Potential In The Pacific Northwest Using An Asian Agro-forestry Model

Karl Bareis
2900 Smith Grade
Santa Cruz, CA 95060

Cultural Perspectives

Over the past ten years I have been working as a language and cultural translator for travelers to Japan: a culture that has been dealing with bamboo for at least 2500 years. The Asians, when they talk about bamboo, talk about it very matter-of-factly, and "Of course, you're gathering the canes in the winter, and use it this way." Usually, I have to answer for most Americans, "No, we are a horticultural country. We import many plants from many countries, but traditionally we have never had natural stands of bamboo." We don't know what a true natural stand of bamboo is. I saw, for example, on the western outskirts of Kyoto, in 1983 with Dr. Ueda, a stand of Phyllostachys heterocycla pubescens, known as 'Moso' bamboo that stretched west across several ranges of low rolling hills, an area 7 km by 4 km. We walked for several minutes in toward the middle of the grove, pausing in the towering silence of the forest of blue green bamboo canes. He said, "It's really unfortunate this grove has only been here for 400 years. It would be much larger given more time."

It struck me in that moment that part of the burden in translation of bamboo culture was to transcend our limited Western attention span. I began in that moment to see that the bamboo grove was a result of human management

stretching back in time and care. Ingenuity and observations collected over time had given Professor Ueda a concept of time which is measured in millennia. Not just in the way of looking at four centuries as being insufficient to realize a plant's full potential. Actually about 370 years ago Moso was imported from China where it had been cultivated for at least fourteen centuries.

During this slow acculturation of this single bamboo species it was purposely transplanted across vast tracts of land where it had not been. It was primarily because of the multi use character of this bamboo with the rice paddy cultures of east Asia that allowed it to slowly attain a very important agro-forestry position, as a food and timber source, and more importantly - an environmental resource for erosion control. Mountain villages have long used Moso to stabilize steep slopes near houses and provide an early spring crop of edible shoots.

Looking at Another Bamboo Species from an Historic Perspective

Beginning in 7th century China, the Tang dynasty, the Chinese have folk stories about the planting of Madake, Phyllostachys bambusoides, along the waterways. During the second emperor there was a crisis that happened because of this bamboo's flowering. The Chinese say that Madake flowers once in every lifetime. It's actually between a 60 to 70 year cycle depending on climate. Traditionally it was grown to provide a lath of split and woven screens that clay could be spread against in residential construction (wattle and daub). The strong root structure prevented wave erosion on the dikes but when it flowered it died along the waterways. Three or four years later the rotten culm bases broke off, and heavy rainfall was followed by the movement and rafting of these culms. The light culms and debris floated very fast along the canals and created dams — a series of dams. In the height of the monsoon flooding over 200,000 people were drowned. We know this, because the temple records talk about that flood. It was repeated many times. Finally, it was realized that this regular long-cyclical flowering phenomenon was going to result in many more deaths from flooding. Eventually methods were adopted in China that whenever it flowered, the bamboo was cut to the ground and the waterways were cleared so the added effects of these dead culms did not increase the chances of a major disaster. This is just one example of the way the Chinese

culture over many generations had learned to interact with the bamboo.

I would like to mention one anecdote to this story. During the mid seventies in Japan, bamboo ecologist Dr. Masatoshi Watanabe observed a decline in post flowering bamboo harvests in areas with agriculture labor shortages. This left the groves were in an unmanaged state. Despite warnings from the University of Kyoto monitoring team, the monsoon floods experienced in 1977 resulted in severe flooding and loss of life. The knowledge of the natural cycle of Madake, and its usefulness as a valuable resource, depends on multiple generations of human farmers understanding the ecology of riverside plantations and the potential hazards. Introduction of any bamboo into a forestry role requires us to take into account the long flowering cycle of bamboo, and the necessity that future generations understand the long term labor intensive relationship. Restoration and agricultural harvesting transcend the ecology of existing forests. Recent harvesting in western forests follows a pattern begun in Asia more than twenty generations ago. Most of the original forest has disappeared after the old growth has been cut and harvested and farming practices instituted.

Bamboo's Food Value

Bamboo, as far as utility is concerned, is divided into three basic categories. The most valuable category is a food source. Since the earliest times, bamboo has been identified as a food resource in China. Moso bamboo was not imported originally to Japan as a timber bamboo, but as a food bamboo. It comes before the first crops at the end of a long winter. This is a very important resource for carbohydrates in this culture, especially following drought. Moso bamboo was a prized resource as an early shoot to be harvested at the beginning of March. It provided the people in the villages with the first vegetable resource of the new growing season. Moso as a food resource has been supplanted now by sweeter forms of bamboo.

Having spoken about the need to see bamboo within the framework of history, I'd like to continue now with new research in edible bamboos. The family of plants that comprise the grasses have been heavily utilized by mankind. Grains have evolved and supported human development as no other plants have.

The grasses evolved within an expanding arid troposphere as the climate slowly dried and cooled to form larger continental regions. This period of early grass evolution was the stepping off point dividing grasses into three categories. Bamboo aligned itself with the mist forests along the equatorial regions where, for whatever reasons, it did not rely on annual flowering to procreate. The bamboo scheme utilized root system expansion to survive with only infrequent flowering. Efficiently cycling nutrients, bamboo has begun to be considered as potentially more efficient than annual grain crops.

The chances are that bamboo will not be able to be engineered to replace grain crops anytime soon, but when the factors of tropical rain forest depletion and population expansion are factored in, then it seems especially appropriate to observe recent developments in Chinese research. One area of recent research is being done in Guangdong Province by Madame Wu. She and her husband, who recently passed away, have done extensive research over the past fifteen years in developing new edible hybrids in bamboo. Most people who know about bamboo realize that creating hybrids in bamboo is very difficult. To create a hybrid you need two species flowering at the same time. Because of the long cycle between flowering, it's very difficult to find two species flowering at the same time, let alone accomplish cross pollination. So, what has happened? In 1980 they identified the problem and were smart enough to suggest a program. Agricultural workers throughout the whole province of Guangdong were incorporated in a massive program to search out bamboos in flower that could be identified as possible pollinators and bring in the pollen to one central locale, and do hand pollinating. They used this hand-pollinating process to increase the chances of getting hybrid bamboos. As of 1991 they were able to produce 220 bamboo seedlings in a special nursery. It is interesting to note from a horticultural standpoint that all the variegated forms were classified as weak and were omitted from the selective process. Seedling nurseries were set up to grow the seedlings and focus on identifying superior traits. Eventually the hybrid seedlings will be selected specifically for their improved dietetic content: increased natural sweetness, protein and carbohydrate content.

The work in China on the potential of tropical bamboo to produce new and useful food resources allows us to envision other goals for future breeding programs. A possible future American Bamboo Society breeding program may

be useful in identifying hardiness factors. By utilizing plants within American collections, progress could be made toward developing hybrid species.

Why is it that Bamboo Never Evolved in Western America?

This is a complex question of limiting climate factors. The most important factor is that bamboo needs to have consistent moisture during the growing season. Another factor is the mean low temperature in winter. Washington and Oregon frequently have temperatures that hover around zero for a few days. That is enough to kill most bamboo to the ground and to shock the surviving rhizomes into much reduced production. However, the key factor is that running bamboo has evolved within the subtropical forests of East Asia where rhizomal development occurs in the summer months.

An efficient approach toward finding hardy bamboo would be to test the seedlings produced by flowering bamboos. Many times these are produced in the thousands and there may be some variation in the seedlings. Genetically, some prove to be hardier than others. Identifying bamboos able to grow throughout the summer without any irrigation is important for the Northwest.

The main limitation in developing of new strains of bamboo for this region is the lack of a program by the American Bamboo Society or Chapters to exploit bamboo resources in Asia. The central region of bamboo diversity in Asia is the Sino-Himalayan belt. We know that Asia, as the subcontinent of India was thrust up against it, was actually lifted physically, and it appears the bamboos took a ride. Some bamboos that were in the forests of Southeast Asia 60 million years ago have been lifted as high as 3500 and 4000 meters. These bamboos survived on limestone karst ridges that started out as sea floor diatoms. Climate factors vary from mountain valley to ridge top exposures. A few isolated species have evolved to withstand cold temperatures driven by the dry winter blasts from Tibet. Therefore, within this region some species have traits which fit a profile of unaided survival in the Pacific Northwest.

Fargesia Type Bamboo

Recent Chinese research has identified 79 species of mountain dwelling bamboos now categorized under the genus Fargesia. Many of these are

endemic to one mountain, several to one slope. These specific locales sometimes give us soil-specific bamboos adapted to, very hardy conditions, because of the type of terrain, especially at the base of the Himalayas where there is a dry region subject to cold.

Forty-four of the 79 species of Fargesia, for example, are endemic to Yunnan Province. Four great rivers flow through this region, the Salween on the west, the Mekong and the upper Yangtse in the central region and the Red River flowing into Vietnam in the south. Each of these rivers has an elevation of approximately 3000 feet with 15,000-foot tall mountain ranges between. This terrain creates isolated environments, some for hundreds of thousands of years. So in Yunnan you will find very different bamboos and also very different plant communities from range to range.

These upland plant communities resemble the plant communities of the Pacific Coast in many ways. They contain temperate evergreen hardwoods like the widely dispersed laurels, but also include rare genera like Castinopsis and Lithocarpus in the beech family. These familiar trees only exist in widely separate forest communities around the Pacific Rim. One may compare our relic redwood forest community, with Mahonia, Rhododendrons and herbaceous plants, to the forests of montane Southwest Asia. The missing family links of rare conifer species found in isolated locations and in association with Fargesia bamboo species, point to climate similarities and soils which predate the interior glaciation of the North American continent. These very interesting plant communities that are isolated from one another by thousands of miles and evolved separately contain the likely possibility that some Asian mountain bamboos, may be adaptable to the coastal climate zone of Western North America.

Within Southwestern China, research has continued to focus on future use of available resources. It would be appropriate to focus on the little known and potentially threatened mountain bamboos as a potential resource for bamboo breeding programs in the Pacific Northwest.

Aside from the Fargesias, most of the bamboo we saw in Yunnan were associated with villages. The lowland timber bamboos were all associated with villages. It is very hard to find endemic populations of bamboo that are not

affected by man. Bamboo and man are connected through utilization in Asia. It is rare to see a derelict, unused patch of bamboo forest on the side of a hill. Every bamboo has its own use; every bamboo has its own story.

Bamboo's Usefulness

How useful is bamboo in replacing a tropical hardwood? Tropical hardwoods, as we know, are being classified as endangered. At the Rio Conference, the European nations decided that they could not import tropical hardwoods after December, 1994. This has created this huge demand for replacement floors, material for doors and cabinets. What are they going to do? They don't have the residual hardwood forests. The attention of Europe is not on bamboo: "We love it, we want it." It is "How are we going to replace these forests?"

A Lesson to be Learned from China

In the last six years the Chinese have developed simple machinery that will handle large caliper bamboo, split it effectively and produce laminated 3" wide tongue and groove floor boards.

To maximize the usefulness of bamboo as an annual forest product, quality control measures are applied from the time that the culms are selected for harvest. Knowledge of the final product requirements allows the team to process a high percentage of first grade material, thus keeping waste and labor to a minimum. The first grade is selected for flooring and weaving, while the weaving grade is smaller in dimension but equal in quality. The second grade is made up of bent culms and one third of the culm at the top. These materials are reserved for chip board, similar to plywood. In China there is a critical need for pulp and fiber for plywood substitutes. The third grade is pulp.

What bamboo is not exported, acts as a replacement for softwoods from the United States, whose importation is no longer being subsidized by the U.S. Forest Service. Up until September 1993, processed pulp was sold at dockside in Shanghai for $80 a ton. That is cheaper than it currently costs to produce within the Willamette Valley in Oregon. Now the Chinese are saying, "OK, it's going from $80 a ton to $120 in one year. We must fully utilize our bamboo resources". The only problem was that somewhere between the harvest and the

market, most of the bamboo products become "export items" to earn cash, and the available pulp for paper is becoming a luxury that the Chinese economy can't afford.

As members of the international community we see the positive and the negative side of this situation. Immediately, it is very positive to provide a substitute for the hardwoods. This produces jobs within China. The negative side is the "productive" harvest currently envisioned for the existing bamboo stands will not stand up in the long term. Forests in China have been severely depleted for many centuries. Currently the forest cover is unable to maintain water quality, soils are lost to erosion and the traditional complex forest ecology is being lost. Now bamboo sustains the village; it provides building materials and myriads of woven containers. However, as technology begins to find uses for bamboo to replace wood, there will be increased harvesting with bamboo being shipped to urban factories and pulping mills. The Chinese are trying to focus themselves. Scientific bodies have been formed and study groups are evaluating the alternatives. The Third National Bamboo meeting was held in November, 1993. Committees of bamboo experts met on product development. However, there was very little talk of the potential to exploit the remaining bamboo stands. Bamboo now represents potential foreign exchange income. Also, the relative ease of harvest and low technology required for manufacturing bamboo products have made bamboo versatile enough to be swiftly incorporated in the "market economy". This is of major interest to bureaucrats trying to increase yields from forestry.

In Conclusion

It is time for cooperation on harvesting and processing efforts. No one of us in the Pacific Northwest are going to be able to plant enough bamboo in 5 acres to actually support a flooring factory. But if 30 or 45 people could produce 60 or100 prime canes each that could add up to something significant. Working together may be a start.

Cooperation between growers will develop standards for the end use of domestically grown bamboo. For example, design a system that begins as the culms are harvested and sorted. The waste from grading and processing delivers material to the pulp mill. Where the selling price of pulp may be $120

a ton. Sixty percent of the bamboo raw material is processed and used for the highest valued end product.

Looking to China gives us the opportunity to examine this labor intensive agricultural process. Farmers cultivate to yield bamboo that grades at the highest level, thus getting the most return for bamboo as a timber product. Finished flooring is a potential valued added product. Prime dried canes for craftsmen could be a more immediate product for bamboo growers. Large scale bamboo plantations may use a small growing variety that can be mechanically harvested for paper pulp. Suitable plantings need to be located close to a pulp mill site for the manufacture of kraft paper.

Whatever the end product, the Asian agro-forestry model demands close attention in the Pacific Northwest. The development of bamboo markets should always focus on the high quality, high value materials that can be a by product of the aesthetic thinning of the bamboo grove.

Plant Bamboo on Your Farm

Daphne Lewis
322 North 82nd Street
Seattle, Washington 98103-4216

Introduction

This paper is intended to inspire farmers to plant bamboo. By the next decade bamboo will move into the "of-course-we-raise-it" category with peas, pumpkins, and sweet corn.

In 1995 farms are larger and farmers are fewer than in 1900. The farmers that remain are either extremely tenacious or unusually able to adapt and try new methods. For a long time "new methods" meant more expensive machinery, more dangerous chemicals, and more concentration on a few crops (usually annual) trucked hundreds or thousands of miles to the buyer. "Efficiency" depended on petrochemicals and huge capital investments. Since the 60's "new methods" has meant questioning the old "new methods". In the 90's innovative farm families are preserving and building their soil, using integrated fertility and pest management, reducing their planted acreage while increasing their net income, diversifying their product line and including value added products, and in many cases direct marketing crops and products. They sow only what they know they can sell.

Let bamboo be part of the forward-thinking farmer's product line. Lovers of bamboo fall into three categories. Plant Lovers love bamboo because of its unique poetic beauty. Save-the-Earth Folks love bamboo because it grows wood faster than trees, yields high volumes of food every year, and protects the soil. Capitalists see a new industry waiting to happen. They want to create

that new industry and be part of it. A farmer who plants bamboo will fall into all three categories.

What is bamboo?

Bamboo is a grass (graminae). Farmers already know grass. Typical farm grasses include annuals such as wheat and corn and perennials such as timothy.

Bamboo is a perennial grass. It differs from other grasses in that its culms are hard, like wood and it bears its leaves on branches instead of the main stem. Bamboo has two kinds of leaves; other grasses have just one. The leaf that encases the new, growing cane (shoot) is a sheath leaf. The leaf that photosynthesizes and grows on the twigs is a foliage leaf. The foliage leaf has a narrow waist between its blade and sheath called a pseudo-petiole. Most other grasses do not have a pseudo-petiole.

Monopodial bamboo has two growth periods each year, up in the spring and out (sideways) in the summer.

(1) In spring bamboo sends new shoots out of the ground into the air. These shoots reach full height two months after poking out of the ground. The new shoots have become new culms.

(2) In summer after culm shooting has stopped, bamboo sends its rhizomes horizontally through the upper few inches of soil. When the soil cools down in fall, the rhizomes stop growing. Bamboo is not growing visibly through fall and winter, but buds on rhizomes are swelling to get ready for the spring rush into the sky.

Plant bamboo to produce income

Why plant bamboo on my farm?

Bamboo is the most useful plant on earth. Plant bamboo to produce income and to enhance livability and beauty. Bamboo is a perennial. There is no need to replant every year. On the farm bamboo produces income three times a year: bamboo shoots in late spring, bamboo poles in winter, and nursery stock in early spring.

Bamboo is an evergreen grass that is 2 to more than 60 feet tall depending on the variety. It buffers traffic noise, provides windbreaks and shade, slows surface water runoff, shades streams, and controls erosion. It is an excellent browse for livestock.

Bamboo poles raised on the farm can be used for fishing poles, fences, trellises and arbors, reinforcing bar for concrete, pins for securing straw bale walls, and props for many childhood games. Asians plant bamboo to revegetate hillsides and to produce wood and food. They craft bamboo into houses, furniture, and everyday items such as chopsticks. In China, Vietnam, and India, bamboo is machined into strips and laminated into wood products such as floor boards, beams, and plyboo panels. It is also used for paper pulp.

Bamboo shoots

Bamboo shoots are the juvenile canes that thrust up out of the ground each spring in a bamboo grove. They are succulent, crisp, and tender like asparagus shoots. Cook them gently and serve them with rice. Accompany them with garlic, onions, carrots and other stir-fried vegetables . Season with soy sauce.

In Asia, bamboo shoots are sold fresh, dried, pickled, or canned. They are not sold frozen. If you dislike canned bamboo shoots, try fresh ones. Canned foods do not taste like fresh ones.

In spring in Beijing, fresh bamboo shoots cost 16 times more than other vegetables. Bamboo shoots from the bamboo called "moso" or "mao zhu" are dug in winter while still below ground. They are stored in sawdust to be sold later. They cost 35 times more than other fresh vegetables. Sheng Ke Xi told me this in November, 1994. Mrs. Xi is a professor at the Research Institute of Forestry at the Chinese Academy of Forestry in Beijing.

People ask "If farming bamboo shoots is such a good idea, why hasn't it been done in the United States?" I don't know. I know that when Japanese immigrants came to the U.S., they had to scramble to learn English and to make a living. No time to import and plant bamboo. Their children did not grow up eating bamboo shoots from the grove outside the back door. The second generation had more time and money than their parents, but no

burning desire to taste bamboo each spring. Farming bamboo did not happen.

PHOTOGRAPHS

1. Henon Grove with Shoots, Chef, and Sharpened Gathering Trowel.

Tim Ogden

And then along came Tim Ogden from Grant's Pass, Oregon. Tim is not a farmer; he is an electrician. Tim jumped right in and "did" bamboo shoots. Tim farmed bamboo without a farm. He did it without any land. And he made money doing it. Tim drove around his city and county. When he spied bamboo he knocked on the owners' door and introduced himself. With some people he negotiated to manage their grove for free. With others he negotiated to weigh his harvest and pay them so much per pound.

Tim thinned out the excess canes from each grove. He shredded the poor poles; trimmed and sold the good ones. When the new shoots came up in spring he harvested them. Not knowing how harvesting was done in Japan or elsewhere, he devised a method using a pruning saw. Works great. Not knowing "there is no market for bamboo shoots", he sold his shoots to restaurants and at the

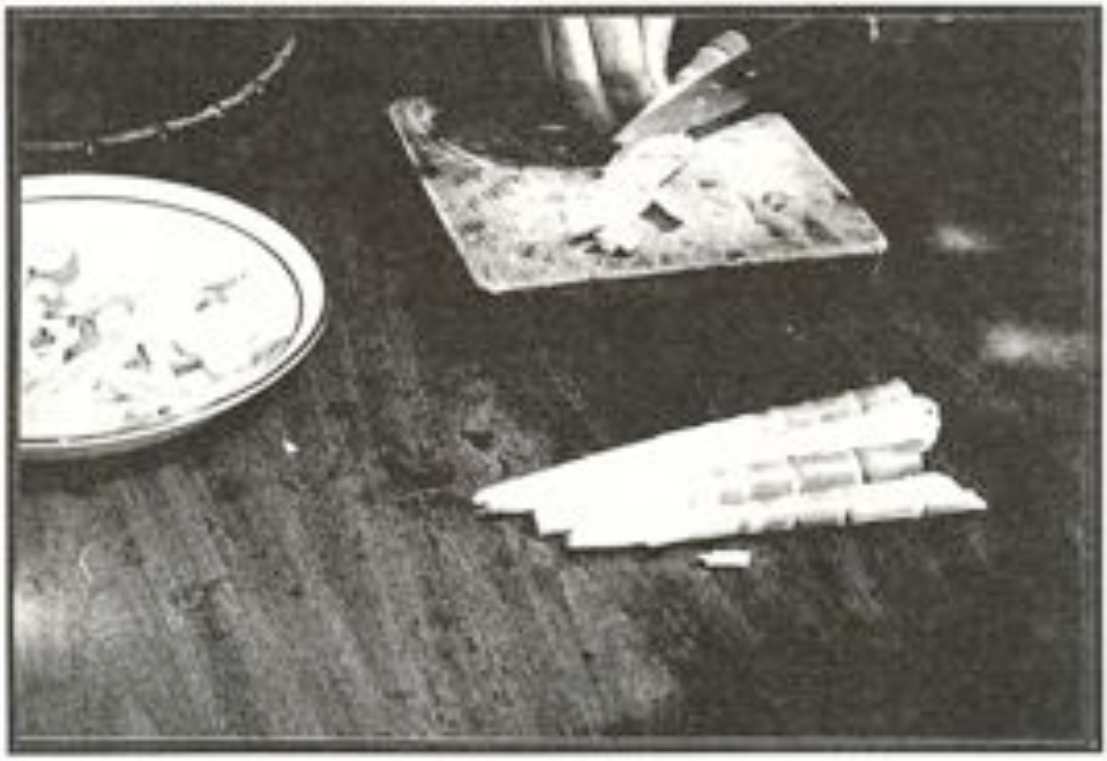
local farmers' market for $2.50 a pound.

2. *Bamboo Basket with Fresh Shoots. Shoots on the left have their culm leaf. Shoots on the right are peeled and ready to be sliced or cooked whole. These shoots were picked in June, 1994, from the henon grove at Bamboo Gardens in Redmond, Washington. The eight different cans of bamboo shoots came from two grocery stores in Seattle.*

Having too many shoots to sell, Tim and his wife decided to freeze them. They rented a freezer locker. Restaurants bought the frozen shoots for $5.00 per pound! Tim showed that the reason bamboo shoots are not available frozen in the United States is not that they don't freeze well, but that Asian households do not have freezers. His frozen bamboo shoots taste great. In 1995 Tim is buying bamboo shoots from other harvesters as well as picking his own. He can not keep up with demand.

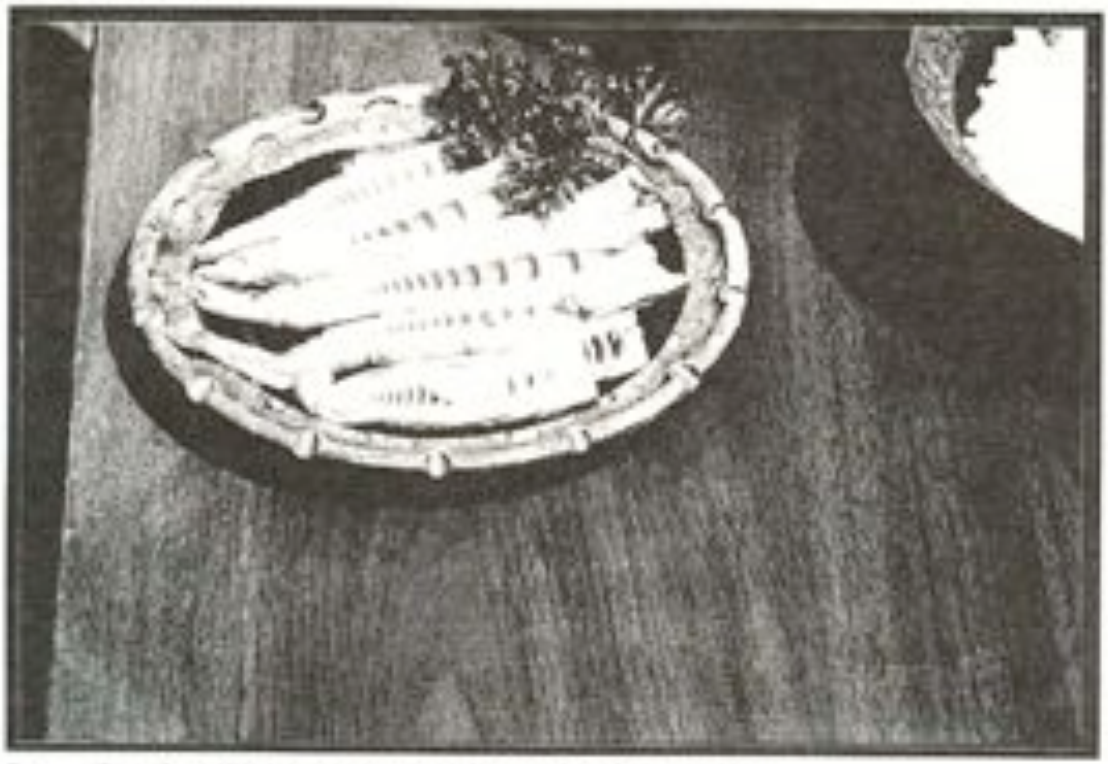
Tim decided to dig bamboo plants from "his" groves and put them in pots to sell. He went into the bamboo nursery business as well as the farming business. That first year he grossed $50,000. He did bamboo part-time, on

weekends or after work. Tim and his wife both have full time jobs -- and a healthy active toddler. To me Tim Ogden is a bamboo hero.



3. *Chopping Bamboo Shoots Before Cooking Them.*

4. *Bamboo Shoots Stir-fried with Garlic, Onions, Carrots and Served in a Bamboo Dish.*



5. *Bamboo Shoots Sliced Lengthwise and Pickled.*

Yields

To my knowledge there is no published work stating yields of bamboo shoots when grown in the United States. Tim Ogden is gathering information on yields of vivax, black, and henon. I intend to do similar research

Japanese farmers harvest bamboo shoots from nearby groves or forests. Management is casual. They report yields of 2 to 5 tons per acre. Chinese farmers (the ones that are written up anyway) manage their groves intensively. They report yields as high as 10 tons per acre.

Let's assume a yield of 4 tons per acre on a U.S. farm and that we can sell the shoots for $2.00 per pound. The acre produces 8,000 pounds. At $2.00 per pound an acre yields $16,000.

How much does it cost to harvest 4 tons of bamboo shoots? What is the net

income? Let's assume the harvest season is two months. Two harvesters work twice a week for a total of 32 days of work. Thirty two days of work times $100 per day is $3200 to harvest. And then there is storing and marketing and whatever. Perhaps the bamboo sells for $16,000 and the cost to harvest and sell it is $5,000. We will know better as more bamboo farming is done in the United States and as more information is gathered from bamboo rich countries.

Bamboo poles

To maximize production of bamboo shoots, it is necessary to water and fertilize the groves and thin canes every year. Give the grove thirty inches of moisture through spring and summer. Fertilize with organic fertilizers such as manures and compost. Remove four year old canes every winter.

To farm bamboo shoots it is necessary to harvest poles. Might as well plan to market them.

High quality poles that are cured and fumigated are imported cheap from China. To compete with Chinese poles a U.S. pole farmer needs to sell a slightly different pole to a different market niche. One such niche is the green (uncured) pole market because green poles are not shipped from Asia. Craft people such as basket makers work best with green material. It splits easily and bends readily. A second niche is high quality ornamental market; blemish free poles that are 4 to 8 inches in diameter. A third niche is the local market. Neighbors may buy or trade poles to prop tree limbs, build fence rails, or train sheep dogs.

A fourth niche is poles longer than 10 feet. Imported poles are between 3 and 10 feet long. Makers of yurts, builders of straw bale houses, and other unconventional pole users need longer poles, 20 feet or so in length. These are not available from existing pole distributors.

Another potential customer is a specialty wood company. They would sell poles as part of its product line.

How many poles are produced per acre? It depends on the diameter. An acre of bamboo forest produces a thousand six inch poles. A similar acre planted to a two inch diameter bamboo might yield 5 times that number, but the price per

pole is much less. Bamboo Gardens sells six inch poles for $25 to $35; two inch poles for around $8.00. I can't predict what farm gate pole prices would be from these retail prices.

Nursery stock

The American Bamboo Society, formed in 1979, has published 15 issues of the "Species Source List". In 1995 the yearly Source List listed 41 vendors and 222 varieties of bamboo. The general public is buying bamboo. Garden centers are stocking bamboo to meet the demand.

A farmer with a planting of bamboo could produce containerized plants, but producing containerized plants is the nursery business not the farming business. More in line with farming is to dig and burlap specimen plants from the groves in winter. Store them in sawdust in shade and out of the wind. In February or March sell the plants to buyers in the nursery industry.

Control bamboo

How does the farmer control the spreading rhizomes of bamboo? I think of five methods. There must be more.

1. Plant the bamboo by a stream or wetland. Bamboo can not grow into saturated soil.
2. Plant bamboo next to native forest. Pacific Northwest summers are dry and our conifer woods dark. Bamboo can not compete with drought and shade. It can not spread into our native forests.
3. Plant bamboo next to pastures. Herbivores love bamboo leaves, and even carnivores such as dogs will eat new shoots. Bamboo can not spread into pasture that is grazed during shooting season.
4. Cut the rhizomes around the perimeter of the grove every September or October. These are the young rhizomes that grew during the summer. They have not rooted yet and will rot in place when severed from the grove.
5. Allow the rhizomes to spread beyond the grove. In spring when new shoots arise from the rhizomes, mow the shoots to six inches or so. Mowed shoots will develop leaves and become a six inch tall meadow. Mow several times over spring and summer as new shoots come up. In February dig the rhizomes and sell them to other farmers or to nurseries. Rhizomes with leaves are much more viable than those without and so have more value.

As years go by large scale customers will buy bamboo. Sewage treatment plants looking for ways to use their sludge and water will plant hundreds of acres of bamboo to produce paper pulp. Highway departments looking to control noise and runoff will plant bamboo along rights-of-way. They will sell bamboo pulp to paper mills.

By selling rhizomes, a farmer creates income from his bamboo grove four ways.

1. He sells fresh bamboo shoots in May and June or frozen ones year around.
2. He sells poles in November and December or year around.
3. He sells specimen plants in February or March.
4. He sells started rhizomes in September or October.

Bamboo can be very profitable indeed. Also, its labor demands spread out into the less busy times of the year.

Plant bamboo to improve the farmscape

Don't plant bamboo in your best fields. Bamboo is suited to the odd shaped, difficult to tractor till places on the farm. It is harvested by people and their hand tools walking in the shade and carrying baskets or pulling carts. Therefore you can plant bamboo on hillsides, stream banks, ditch edges, stony places, and small fields too awkward for easy tractor farming.

Buffer farm buildings from the road

Plant a grove of bamboo between the farm buildings and the road. Reduce noise, create privacy, catch dust, and reduce heat. Let birds gather in the safety of the grove. Cats can not climb bamboo.

Create wind free pockets

Plant a hedgerow of bamboo to break or filter the wind and shade the pasture.

Shade employee housing

Employee trailers and houses bake in summer sun and have no privacy from passing motorists or other farm activities. Plant groves of bamboo to make the housing more comfortable and the yards more private and enjoyable.

Shade ditches and streams and protect them from storm water runoff

Anadromous fish need cold, oxygen-rich water that is free of silt and chemicals. Adult salmonids do not spawn in tiny streamlets on farms. The fry, however, once they are hatched from their gravel beds disperse into these tiny habitats. Each heated, degraded farm stream leaves one less home for young fish to grow and hide in.

Warm water carries less dissolved oxygen than cold water. Water that runs through pastures and fields is heated by the sun. Its ability to carry oxygen is significantly reduced. It is also damaged by runoff that carries silt and dissolved pollutants such as urine and fertilizers. Bamboo planted on the edges of these streams and ditches provides shade in winter and summer; the stream is less likely to heat up. The rhizomes and accumulated leaf litter between stream and pasture catch and use all runoff. It can not enter the stream.

Love your streams and wild fish. Plant bamboo.

Create privacy between the farm and neighbors

Housing tracts, church parking lots or even shopping centers surround many farms. Plant a grove of bamboo along the property lines. Create a buffer between these neighbors and you. Go about your business with separation and privacy.

Hide and shade the sani-can

The sani-can sits in the sun by the edge of the field. It bakes. Place it in a grove of bamboo for comfort, seclusion, and dignity.

Plant the odd shaped parcel

Between the railroad tracks and the neighbor is a small piece of land. Plant one kind of bamboo here. Between the dike and the access road is another odd piece. Plant a second kind of bamboo there. And so on. There are lots of odd places that could be planted with bamboo.

Plant the levees and flood zones

Bamboo will withstand occasional flooding as long as aerobic soil conditions return within a few weeks. Bamboo along the dikes and levees would strengthen them with its interlocking rhizomes. In the flood zones between the river and the levee, bamboo can temper the power of the waters.

Fertilize and water bamboo with manure lagoon liquids

Bamboo is greedy for nitrogen and water. The more water and fertilizer it receives the more it will grow. (There must be limits, but I don't know what they are.) Liquid manure is perfect fertilizer for the giant, woody, evergreen, ever- greedy grass.

Create shade for the vegetable stand

Sell bamboo shoots at the vegetable stand along with other May and June produce. Let your customers pick their own shoots in the grove that shades and protects the stand. Put a picnic table in the grove. Let your stand be inviting and unique. Let your bamboo grove invite customers in and encourage them to stay (and buy).

Fig. 6 Farm With U-Pick Fields and Vegetable Stand

1. Plant a Timber Bamboo Forest between highway and frontage road to buffer noise, provide privacy and clean air, and to advertise availability of bamboo shoots and poles.

2. Plant groves to north of farm buildings and U-Pick fields to buffer winter winds and summer dust.

3. Plant bamboo along river to protect banks from erosion.

4. Plant U-Pick groves alongside customer parking lot to cool sales area, give privacy to farmhouse, and allow customers to picnic and pick their own shoots.

5. Plant grove to west of farmhouse for summer shade.

Northwest Experiences in Bamboo Agro-forestry

Rick Valley
P.O. Box 86291
Portland, OR 97286-6353

The bamboo renaissance began in the Pacific Northwest around 1980. Jim Orjala, influenced by the cover article in National Geographic magazine began the bamboo project at Aprovecho Institute near Cottage Grove, Oregon, and wrote the section on bamboo in the bioregional handbook, The Future is Abundant (Tilth, 1981). This set the tone for bamboo interest in the region for years to come. Bamboo was looked at as a useful plant and a potential new crop. Many people looked for bamboo to serve a new role in culture and agriculture.

I decided to stop considering the idea and begin a bamboo nursery during a workshop by Jim Orjala and George Gonzales given in 1981 at a weekend permaculture conference. They presented bamboo as a solution to depletion of forest resources in the Pacific Northwest, and an ideal crop for a diversified farm. Orjala had just begun the Aprovecho Institute bamboo project near Cottage Grove which was to provide a prototype for planting bamboo (primarily Phyllostachys nigra 'Henon') into clearcuts, forest openings, and along streams in forest and agriculturally marginal lands.

I quickly found that the normal summer drought pattern of our Northwest maritime climate was a major limiting factor in growing bamboos. Most of the hardy species are from East Asia, a climate with high summer rainfall. In fact, John Isaacson, owner of New Zealand's primary bamboo nursery, maintains that bamboos cannot succeed naturally in a place with less than 40" of rainfall per year. My home receives 36". There are few areas in the world with both a Koppen classification "cool Mediterranean" climate and native bamboo: South

Africa has a very small area of highlands and one species, and Chile has only slightly more area and species diversity. Thamnocalamus tessellatus from South Africa does well here, but introductions of bamboo to our region have not been from bamboo's southern range in Chile . Europe is the largest part of the world with similar climate, but no bamboo species. Compared to the southern hemisphere our climate is harsher in the length of the summer dry season and the occasionally severe winter cold.

As I ranged about the Northwest looking at bamboo I very quickly observed that the best stands were growing either in close association with homes and humans, or in riparian zones. These groves include the largest Phyllostachys nigra I have heard of (Oak Grove, OR, 40-45 feet tall and 2.5 inches in diameter), and the (probable) original introduction point of Phyllostachys nigra 'Megurochiku' to the U.S. at Kubota Gardens in Seattle. Same other fine bamboo stands are Phyllostachys nigra 'Henon' at Toledo, WA. Phyllostachys bambusoides along Bear Creek., Lincoln County, OR . In Shelton, WA there are nice stands of Phyllostachys nigra, P. nigra "Megurochiku, and P. bambusoides. In Washougal, WA there is more nice Phyllostachys nigra 'Henon'. Most of these stands do not get optimum maintenance, and many have gone through periods of neglect. Nonetheless, they are good examples of the potential of bamboo in this region.

These established species are all Asian in origin. The lesson was very clear: irrigate or plant by water to replace the lack of rainfall during the growing season. I developed another idea by testing many species in my nursery. Early initiation of shoot development is a desirable characteristic in our climate. Early growth is more likely to be completed due to better moisture levels. I have not seen late frosts harm new shoots as Adam Turtle has reported from Tennessee. Our cooler maritime nights may delay shooting sufficiently to avoid this problem.

Increasing Bamboo Diversity in the Pacific Northwest

Fargesia nitida from Gansu, Western China, may have been first planted in the Northwest at the Hoyt Arboretum in Portland, where it persisted for years, unnoticed and unlabeled, and it survived very well. Phyllostachys bissetii, from Szechwan, W. China, was planted on Vashon Island and then in Portland by

myself some years later. P. bissetii thrives in our region, with early shoot development and hardiness sufficient to grow in colder microclimates without problems. Many other less-known species are proving to do well here, showing that continued introductions and evaluation are justified. The Pacific NW chapter of the American Bamboo Society has been the primary group involved in this work. As Karl Bareis noted in his presentation, Western China is extremely diverse geographically and climatically. I believe most new introductions for the Pacific Northwest will come from that region of the world.

A Bamboo Polyculture

Due in part to my permaculture viewpoint, I look to plant more than bamboo monocultures. Both plants and animals can be considered. Many people have successfully included bamboo with poultry in the Northwest, including Larry Reuter of the ABS. A now-removed stand of Phyllostachys aureosulcata once sheltered ducks in Westmoreland Park in Portland. Trees I have successfully intercropped with bamboo include Black Locust (Robinia pseudoacacia) and Red Alder (Alnus rubra), I have used Raspberry (Rubus), Potato, and Comfrey (Symphytum) as nurse crops for new bamboo plantings. (See "A Bamboo Guild" in Bamboo in Permaculture by Rick Valley)

Clearly, we can get involved with irrigation technology, or we can plant bamboo where the water is. If you are designing ecologically, you locate plantings where they will do the best with the least input. In many situations there will be places where water is available even in our climate. Our dry summers mean that running bamboos may be unable to grow away from wet areas, so invasiveness is less of a problem. (Bamboo in Permaculture Design, PNW Chapter, ABS Newsletter, 1988 and Temperate Bamboo Quarterly, 1995 revised by Rick Valley)

Another ecological concern which we must address if we are looking at planting bamboos in riparian zones and other wetlands involves introducing non-native species into these situations. I believe that we can demonstrate that useful bamboos can be integrated into native wetland ecologies already disturbed by agriculture without unleashing the sort of rampant, displacing invasiveness seen with canary reed (Phalaris arundinaceae) or purple loosestrife (Lythrum virgatum). Bland assurances are not likely to persuade the bambusaphobes

and "natives-only" wetland proponents, though. One tactic I think may be of value is documenting the bird species which use bamboo in nesting or as shelter. (I recommend the Peterson Field Guide, Western Birds' Nests). Another needed task is working out which native plant assemblages are compatible with bamboo plantings.

In the mid 1980's I started investigating the work of the Australian engineer, P.A. Yeomans, (The Challenge of Landscape, Water for Every Farm) whose techniques of rainfall harvesting, earthworks and whole farm design are referred to collectively as the "keyline system". A working example of this system in the Northwest is best seen at the Hegge ranch in Oakland, Oregon. (The Permaculture Activist #53, 1995). This is primarily a grazing operation, although there are a few young bamboo plantings. Keyline design has been a primary influence in permaculture design. (Permaculture, A Guide to a Sustainable Future). The importance for this work to NW agriculture is that it gives a method for small scale projects to develop water resources which are farmer-controlled and watershed enhancing, in these times of lowering water tables and increasing regulation of water rights. Following these methods creates numerous niches for bamboo plantings. (Bamboo in Permaculture Design)

Constructed Wetlands and Bamboo

As a fiber crop, bamboo can be a way to exploit water which carries pollutants not advisable for contact with food crops. Bamboo has been planted successfully in Arizona in residential sewage treatment wetlands. (Bill Steen, personal comment) Bamboo has performed well in a number of farm plantings I have seen around the world where high-nitrate runoff concentrates. (Worsfeld Farm, Waiheke, NZ) From such an informal situation it is a short step to purposefully designed swales and other absorption features planted with bamboos. (Permaculture..Mollison, Bamboo in Permaculture Design, 1988, 1995, Rick Valley) I think that a municipal sewage treatment wetland might be the best way to produce a commercial quantity of bamboo in this region. Some questions we need to answer on these applications are: How well do the various bottom sealing methods for ponds withstand bamboo rhizome penetration? How do the various bamboo species fare as regards inundation and changes of water level?

and "natives-only" wetland proponents, though. One tactic I think may be of value is documenting the bird species which use bamboo in nesting or as shelter. (I recommend the Peterson Field Guide, Western Birds' Nests). Another needed task is working out which native plant assemblages are compatible with bamboo plantings.

In the mid 1980's I started investigating the work of the Australian engineer, P.A. Yeomans, (The Challenge of Landscape, Water for Every Farm) whose techniques of rainfall harvesting, earthworks and whole farm design are referred to collectively as the "keyline system". A working example of this system in the Northwest is best seen at the Hegge ranch in Oakland, Oregon. (The Permaculture Activist #53, 1995). This is primarily a grazing operation, although there are a few young bamboo plantings. Keyline design has been a primary influence in permaculture design. (Permaculture, A Guide to a Sustainable Future). The importance for this work to NW agriculture is that it gives a method for small scale projects to develop water resources which are farmer-controlled and watershed enhancing, in these times of lowering water tables and increasing regulation of water rights. Following these methods creates numerous niches for bamboo plantings. (Bamboo in Permaculture Design)

Constructed Wetlands and Bamboo

As a fiber crop, bamboo can be a way to exploit water which carries pollutants not advisable for contact with food crops. Bamboo has been planted successfully in Arizona in residential sewage treatment wetlands. (Bill Steen, personal comment) Bamboo has performed well in a number of farm plantings I have seen around the world where high-nitrate runoff concentrates. (Worsfeld Farm, Waiheke, NZ) From such an informal situation it is a short step to purposefully designed swales and other absorption features planted with bamboos. (Permaculture..Mollison, Bamboo in Permaculture Design, 1988, 1995, Rick Valley) I think that a municipal sewage treatment wetland might be the best way to produce a commercial quantity of bamboo in this region. Some questions we need to answer on these applications are: How well do the various bottom sealing methods for ponds withstand bamboo rhizome penetration? How do the various bamboo species fare as regards inundation and changes of water level?

A FEW EXAMPLES OF BAMBOO PLANTING IN THE PACIFIC NORTHWEST

The Aprovecho Institute Bamboo Project, Cottage Grove, OR

These plantings were begun in 1981, and all but a few specimens are Phyllostachys nigra 'Henon'. Not long after the project was begun, the originator, Jim Orjala, left the Northwest, and left the project in the hands of other volunteers at Aprovecho. To my knowledge, none of the volunteers have stayed with the job more than a year until recently. From time to time I have consulted or taught a workshop there, and so have kept in touch with the development of the plantings.

One 'Henon' bamboo, planted after Orjala's departure, at the bottom and southern end of the vegetable garden, did very well indeed. Relatively good soil, irrigation and a continual mulch of pulled weeds worked wonders. This planting also very effectively demonstrated that bamboo can prevent cold air drainage and cast deep shade. As the bamboo grew, so did the frost pocket in the garden above. This bamboo was sold off as nursery stock, and the garden has recovered.

Another of the plantings at Aprovecho was in openings made in the second growth forest by cutting out some non-timber species trees. To my knowledge this is the only planting of this type attempted in the region. No irrigation has been provided. Of the original forty starts of bamboo, a third or more died. The rest have grown, though not expanded beyond the initial plantings. After six years, there was a closed canopy of native forest grown back over the bamboo. Beginning in 1990, some thinning cuts on the encroaching alder (Alnus rubra) and cascara (Rhamnus purshiana) have been made. The slash has been used for mulch on the bamboo, which has responded with an increase in size and the slight beginnings of spreading by rhizome growth.

A Whidbey Island Permaculture Design

In 1987 and 1988 I had the opportunity to supply the bamboo and planting expertise for a two family development on Whidby Island, Washington, designed by Bill Mollison. The plantings used important features of keyline

In 1987 and 1988 I had the opportunity to supply the bamboo and planting expertise for a two family development on Whidby Island, Washington, designed by Bill Mollison. The plantings used important features of keyline design. Bamboos were planted along constructed and existing ponds. Species used were Phyllostachys nigra, P. nigra 'Henon', P. nigra 'Bory', P. bambusoides, P. angusta, and Semiarundinaria fastuosa viridis. No one with agricultural or landscape experience has worked continuously on the project, and beyond supplemental irrigation the first seasons, the bamboo has been neglected. Other plans for horticultural enterprises have not been followed up by the residents.

The bamboo plantings along the ponds (fig. 1) have done the best. In my opinion, there is only thinning and mulching to be done to bring them into a productive state after eight years of growth. Removing older culms allows new growth in the initial clump area. Removing smaller culms can suppress the smaller rhizomes from which they grow. This leads to a more uniform stand of larger culms. (Studies on the Physiology of Bamboo, Ueda, 1962). I feel thinning is also important for control of rodents, through diminishing cover. For these plantings, the bamboo was controlled by trapping it between the ponds and the access road. Forest trees block the narrow ends. (fig. 1)

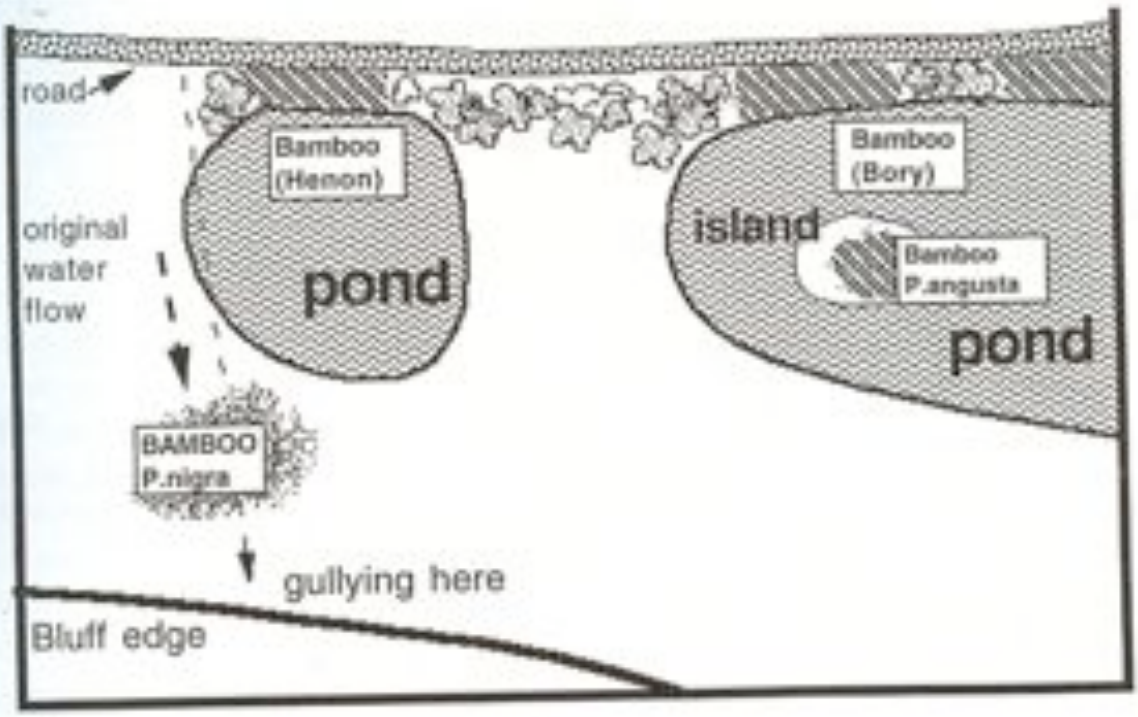


Fig. 1

Phyllostachys angusta was planted on an island as potential shelter for waterfowl. Unfortunately, the pond has been overrun with canary reed (Phalaris arundinacea) and a weeping willow (Salix babylonica) planted on the same small island. (See my discussion on a bamboo guild below) At the time of my last visit in 1994, I could not see the P. angusta from the entry road nearby.

The Phyllostachys nigra was planted on a gully filled with excavated spoil, to prevent any further erosion from water escaping from the pond system in that direction. Some initial tree chip mulch was provided, but little irrigation. There was no soil preparation or cover cropping prior to planting the bamboo. This bamboo is in very poor condition, with some clumps dead.

The Semiarundinaria fastuosa viridis was never moved to its intended location, to screen a swimming hole. Instead, it was planted into a 'nursery row' with a few of the P. bambusoides, and now makes a fine illustration of my rule of thumb that Pleioblastus, Arundinaria and Semiarundinaria will perform better in poor conditions than Phyllostachys bamboos. The area is basically old hayfield, with quack (Agropyron repens) and orchard grass the dominant species. The Semiarundinaria is visibly greener and taller than the P. bambusoides. The tallest plants in the area are about ten feet high.

The largest planting on the property is a two acre area on a northeast slope. Among the small alders and Scotch pine (Pinus sylvestris), we planted P. bambusoides from five gallon cans on ten foot centers. Immediately below is a three acre pond which had water available for occasional irrigation. Ten years later, the alders have closed canopy above the bamboo which has not run. However, some clumps have culms up to 15 feet tall. These P. bambusoides plants do not show the signs of nitrogen deficiency that the field plants do. In my opinion, cutting and chipping the alder, and thinning the bamboo, with irrigation in August and September to encourage rhizome spread, would quickly result in one of the largest bamboo groves in the Northwest. (fig.2)

The Lindenhof wetland planting

In 1988 I began consulting on a project developing a diversified farming

operation on 50 acres (initially) near Independence, Oregon. One area was a four acre canary reed swamp around the inlet to a five acre reservoir. (fig 2) Directly upstream is a 2,000 cow dairy farm with ineffective waste disposal. Nutria (Myocaster coypu) are plentiful in the reservoir and continually disrupt the dikes around the settling ponds at the dairy as well. To enhance the waterfowl habitat and increase uptake of the nutrient inflow, the stream was rechanneled from the straight cut ditch to a longer series of wide meanders. At the reservoir edge, islands were cut, and the area planted with a wide variety of, primarily native, trees and shrubs. The central area of "fingers" defined by the meanders, was planted with swamp cypress (Taxodium) and three test clumps of bamboo (P. vivax and P.bambusoides) The canary reed was mulched down with grass seed straw. (fig 3)

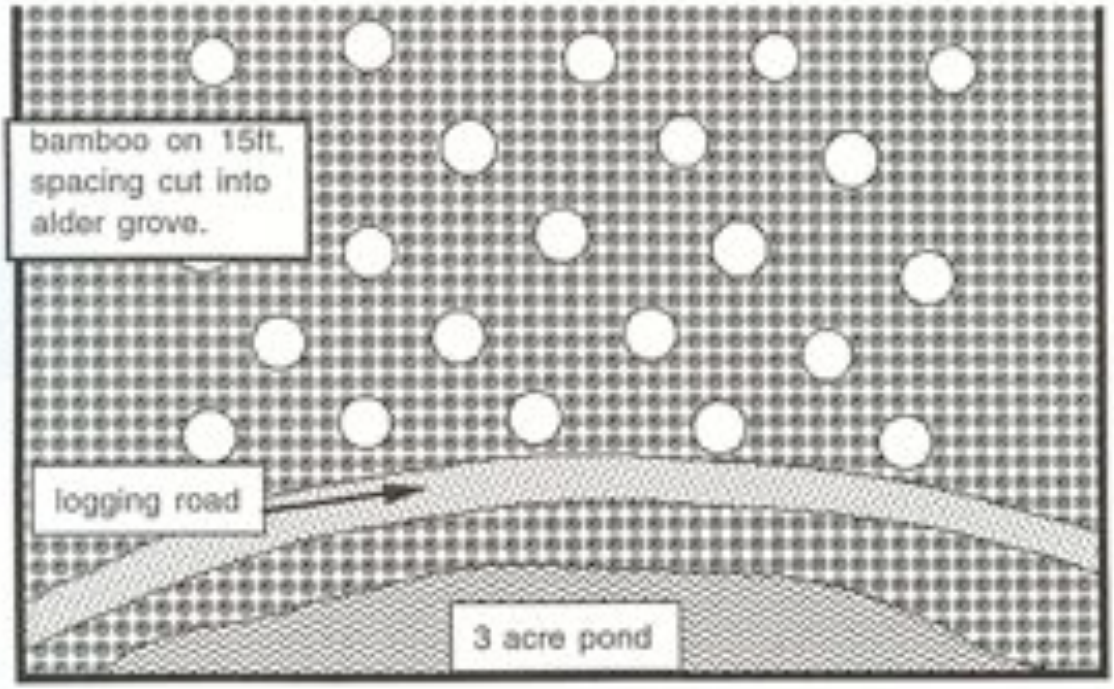


Fig. 2

A flood tested the design the first winter, as the reservoir spillway was blocked temporarily once during heavy rains. Rodents, as feared, were definite pests, killing many trees. We retaliated with hunting perches for raptors and poison baits not toxic to predators, and mowed the regrowing canary reed. Some grass control was afforded by the huge numbers of geese which moved in to roost on the islands, even though some of the trees were literally trampled to death.

In late summer of 1990 we planted 30 two and three gallon pots of P. bambusoides onto the peninsulas. The following spring the funding failed and the project was dropped, so no pest control or other maintenance was done as follow-up. At least one time, cows got loose into the area. In 1994, by inspection, no bamboos could be found. One species of willow, out of many, is all that remains of the tree plantings, and Canary reed waves supreme and unchallenged over all.

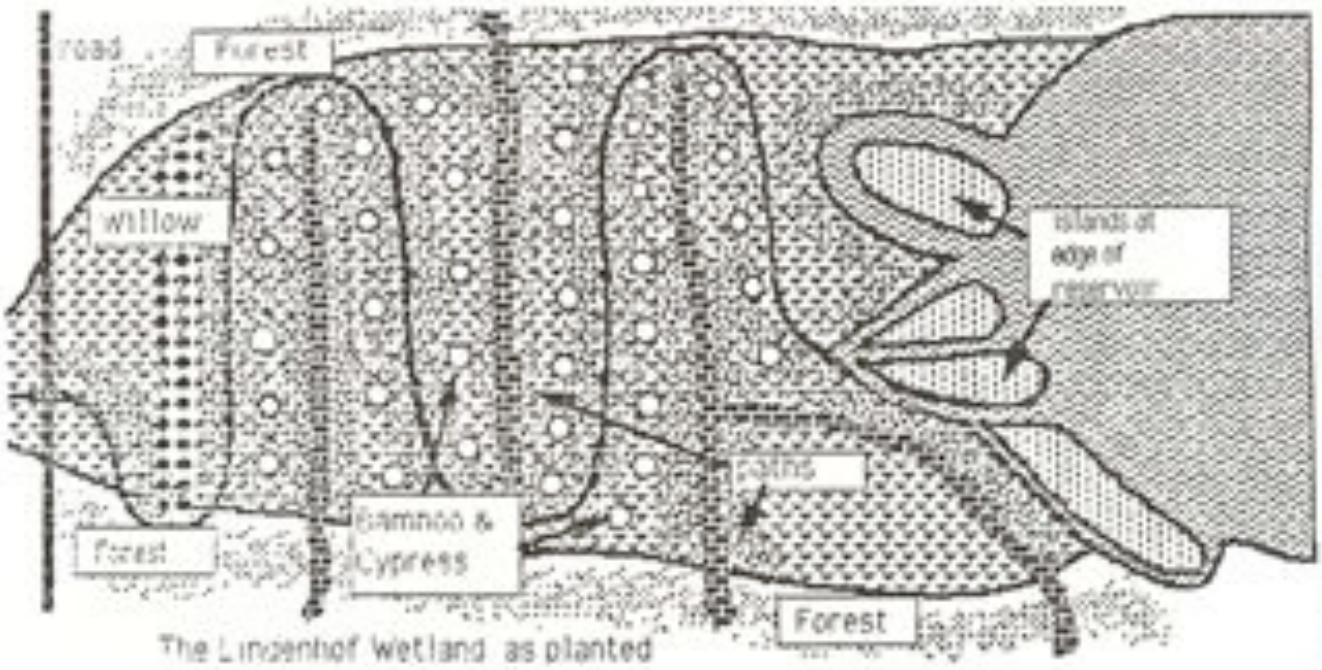


Fig. 3

Linnaea Farm- Cortes Is., B.C., Canada

In 1990, as part of a workshop, we planted one two-gallon pot of P. decora on a terrace below the outlet of a barnyard drain. The concept has the bamboo absorbing some of the nutrients from the water draining to the nearby lake. There is a garden area adjacent and the bamboo has received some care, mainly weeding. The bamboo has grown rapidly, and has become a small grove in 5 years. (fig. 4)

Conclusions

In the Pacific Northwest, large bamboos are riparian plants. Even so, it is

evident that planting bamboo in a riparian zone does not guarantee success. Well adapted Eurasian grasses not only offer significant competition to young bamboos, but shelter rodents which find bamboo more palatable than the grasses. Bamboos, nonetheless, can be grown here without summer irrigation if planted in suitable locations.

Many landowners interested in planting bamboo have no experience with it. Those of us who are promoting and supplying bamboo need to educate our clients more effectively and to offer support and follow up inspections to ensure success in plantings. Bamboo professionals should check with and report on experiences to each other.

It is probable that due to our unique climate, many of the best bamboo species for us will be different from those grown elsewhere. Evaluation of species already introduced to North America but rare in the Pacific Northwest should continue. The quarantine greenhouse established by the PNW Chapter, ABS, should remain a priority so that new introductions can more easily be acquired. We should also remember to continually evangelize for bamboos which may not be available "in the (large wholesale nursery) trade" or mentioned in nationally distributed reference books.

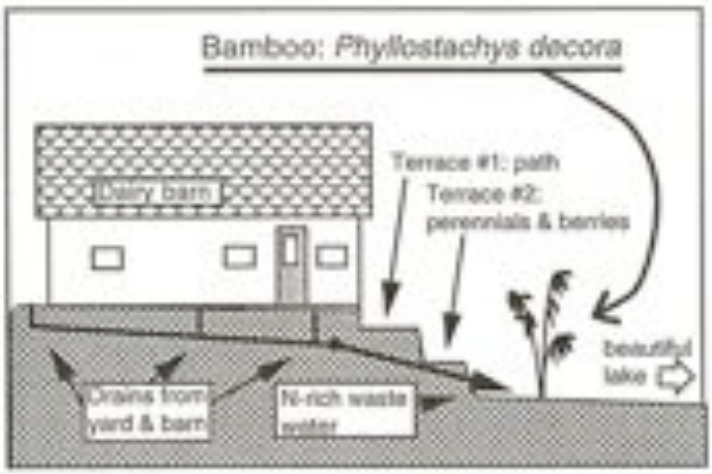


Fig. 4

Regardless of whether it is a good idea to convert clearcuts to bamboo forests here, it does not seem feasible. Productive plantings exist and are being done, but for quick establishment of large plantings the potential bamboo rancher

must consider making an investment in labor and capital which can increase inversely with the skill with which the planting is designed. Site considerations (including soil and hydrology), species selection, and horticultural support through establishment to harvest are all key ingredients .

The Pacific Northwest Chapter of the ABS has been of great importance in developing interest and knowledge about bamboo in our region. Almost everyone involved with bamboo has been touched by our work in some way. Bamboo is now a "new crop", and people are harvesting, crafting, and selling bamboo all within ten years. Not bad for a start! I would like to thank all my fellow members for their enthusiasm and hard work.

References

Marden, Luis, Bamboo the Giant Grass, National Geographic Magazine, Oct. 1980.

Korn, Snyder & Musick, ed. The Future is Abundant , Tilth, 1981

The Temperate Bamboo Quarterly, Vol. II, #1-2, 1995

Yeomans, P. A., The Challenge of Landscape, reprinted by Franklin Espriela, P.O. Box 206, Guinda, CA 95637

Harrison, Hal H., Western Bird's Nests, Peterson Field Guide Series, Houghten Mifflin, 1979

Mollison, Bill, Permaculture: A Practical Guide for a Sustainable Future, Island, Covelo, CA 1990

Ueda, Studies on the Physiology of Bamboo with Reference to Practical Application, Resources Bureau, Science and Technics Agency, Prime Minister's Office, Japan, 1960

Non-wood Fiber Sources for Pulp and Paper Production in the Pacific Northwest

Daryl Ehrensing
Oregon State University
Department of Crop and Soil Science

Softwood fiber from Douglas fir has been the basis of the Pacific Northwest pulp and paper industry for many decades. Many people are quite surprised to learn that other sources of fiber are available that can be substituted to produce these products without the need to harvest trees. Most of the world outside North America and Western Europe have never had access to inexpensive timber resources and have always used non-wood fibers for pulp and paper production.

Recent changes in the Pacific Northwest timber supply have forced local paper mills that for years relied on inexpensive wood chips as a by-product of the wood products industry to compete for increasingly scarce timber resources. This has renewed interest in nonwood fiber sources to augment or replace wood fiber in a wide range of products. Most of the technical knowledge and practical experience with paper production from nonwood fibers is to be found outside the United States.

Non-wood fibers are all around us, and we use them every day without realizing their origin. Regardless of their source, these fibers can generally be classified in one of four broad categories. These are listed below with a few examples of each type.

Non-wood Fiber Sources

Culm Fibers - Cereals, Grasses, Reeds, Canes, Bamboos

Bast (Phloem) Fibers - Flax, Hemp, Kenaf, Jute

Leaf Fibers - Sisal, Abaca, Palm, Henequen

Seed Hull Fibers - Cotton, Coir

Even a brief look through the world literature reveals a large number of species that have been exploited for a wide variety of fibers. Although many fiber crops are grown around the world, the vast majority are adapted to tropical and semi-tropical regions. The limitations imposed by the temperature and rainfall patterns in the Pacific Northwest narrow the list of viable choices for use in the region very rapidly. The following crops appear to hold the best potential as fiber sources for high quality paper production in the Pacific Northwest.

Grass and Grain Straw

"Waste" straw from cereal production has been used in paper production for many centuries, and the paper making technologies using cereal straws are well developed. In fact, the first paper mill built in Oregon used wheat straw as its raw material. Many countries around the world continue to rely on cereal straw as a primary resource for the production of paper.

More recently, a large supply of straw from grass seed production has become available as a result of the phase-down of open field burning in the Willamette Valley, Oregon. While relatively inexpensive, this straw does present some problems for paper makers. As an additive in liner board or cardboard production fibers from grass seed straw greatly reduce the speed with which water can be removed from the mat of paper as it emerges from the paper

machines. While this sounds insignificant, lowering the efficiency of this machinery has significant effects on the economics of paper production. In addition, all grass straws, including cereal straws, are high in silica when compared to wood fiber sources. This can create serious problems in recycling the chemicals used in the pulping process.

The average total production of wheat, barley, oats, rye, and triticale in the Willamette Valley is estimated at 185,000 acres annually with wheat accounting for more than 75% of the total. Minimum annual straw production in the Willamette Valley is in the range of 500,000 tons. In excess of 600,000 tons of grass seed straw are also produced annually in the Willamette Valley.

Many other grass species may be identified that are well adapted to the region and produce high quality fiber as well as large amounts of biomass per acre.

Advantages:

Immediate availability as a fiber source
Low cost
Relatively high production per acre
Needs little refining

Disadvantages:

Transport and storage costs
Short harvest time
High silica
Low drainage rates

Flax (Linum usitatissimum)

Flax is one of the oldest crop plants exploited for fiber. Woven fabric samples recently found in Europe have been dated to almost 10,000 years ago. Flax can be grown either for linen and industrial fiber uses or as a source of linseed oil or meal. Before the advent of the cotton gin, flax was the major textile fiber used in the temperate zone.

In the United States, flax has been grown in nearly every state and was brought with European settlers in the earliest westward migrations. Fiber flax was grown in western Oregon as early as 1843, and by the 1940's as much as 20,000 acres were grown annually in the Willamette Valley, primarily for production of linen thread and yarn. In those days fiber flax generally produced 1 1/2 to 2 tons of dry matter per acre. A fall-planted oil seed flax variety was developed in the late 1940's at Oregon State University, but the fiber flax industry disappeared before winter-hardy fiber varieties could be developed. Current western European yields average over 3 1/2 tons per acre. Production potential in the Willamette Valley with new varieties and improved agricultural technology is unknown.

Flax fiber has a long history of use in paper making. High quality paper has traditionally been produced from processed flax fiber and shives (the woody part of the stems), however, direct pulping of whole straw is also possible. Most of the flax used in paper in this country is a byproduct of oil seed production in the Dakotas and the Canadian prairie. After combining the low-growing oil seed flax, farmers typically bale the "waste" straw for shipment to the paper mill. Flax straw is used to produce very high quality, high strength papers used in cigarette paper, tea bag paper, airmail envelopes, and even U.S. currency.

Advantages:

Very high quality fiber
Oregon is a known high quality production area
Fall planting is possible

Disadvantages:

Relatively low production per acre
Not well adapted to poorly drained soils

Kenaf (Hibiscus cannabinus)

Kenaf has been in the news for the past several years as a new source of fiber for paper. This summer annual can produce relatively high biomass yields

Table 1. Fiber dimensions of non-wood fibrous materials.

Source of fibers	Length in microns			Diameter in microns			L/D
	Max.	Min.	Average	Max.	Min.	Average	Ratio
STALK FIBERS							
Cereals - rice	3480	650	1410	14	5	8	175:1
- wheat, rye, oats, barley	3120	680	1480	24	7	13	110:1
Grasses - esparto	1600	600	1100	14	7	9	120:1
- sabai	4900	450	2080	28	4	9	230:1
Reeds - papyrus	8000	300	1500	25	5	12	125:1
Canes - sugar (bagasse)	2800	800	1700	34	10	20	85:1
- bamboo (wide range)	3500-9000	375-2500	1360-4030	35-55	3-18	8-30	135-175:1
BAST FIBERS							
Textile flax tow	55000	16000	28000	28	14	21	1350:1
Seed flax tow	45000	10000	27000	30	16	22	1250:1
Kenaf	7600	980	2740			20	135:1
Jute	4520	470	1060	72	8	26	45:1
Common hemp	55000	5000	20000	50	16	22	1000:1
LEAF FIBERS							
Abaca	12000	2000	6000	36	12	20	300:1
Sisal	6000	1500	3030			17	180:1
SEED HULL FIBERS							
Cotton stable	50000	20000	30000	30	12	20	1500:1
Cotton linters	6000	2000	3500	27	17	21	165:1
WOOD FIBER							
Conifer	3600	2700	3000	43	32	30	100:1
Deciduous	1800	1000	1250	50	20	25	50:1

when grown under warm conditions with adequate moisture. Research on kenaf production and processing has been carried out by the USDA since the 1920's, and many paper and composite products have been developed. Very recently several attempts have been made to establish kenaf plantations for production of newsprint in Texas and other southeastern states. As a member of the genus Hibiscus, kenaf is adapted primarily to semi-tropical areas with high summer rainfall. Kenaf can be grown in the arid west under irrigation. Very limited trials have been conducted with kenaf in the Pacific Northwest.

Requires irrigation
Short harvest time

Hybrid Poplar (Populus trichocarpa x P. deltoides)

Hybrid poplar has been in the news a great deal in the last few years, and it is included because these short rotation trees are grown more like an agricultural crop than a traditional forest species. In the Pacific Northwest, work with hybrid poplar began at the University of Washington and by the Crown Zellerbach Corporation in the 1960's. Commercial plantations on the lower Columbia River were later taken over by the James River Corporation and in the Hermiston area by Boise Cascade. There are currently approximately 30,000 acres in production on the well-drained soils of the lower Columbia River and 10,000 acres under drip irrigation near Hermiston. These are grown on 8 to 10 year harvest rotations under intensive management.

Hybrid poplar is easily propagated vegetatively by inserting simple cuttings of year-old wood into the ground in early spring. The cuttings generally root and grow rapidly, up to eleven feet per year under ideal conditions. Since hybrid poplar is very shallow rooted, good chemical weed control must be maintained through the first several years to reduce competition and promote rapid growth. This intensive cultural practice is essential to the economics of short-rotation poplar production. Commercial producers are reluctant to reveal cost and yield data, however, well managed hybrid poplars appear to yield 8 to 10 tons of dry matter per acre per year. From a U.S. paper makers' point of view hybrid poplar is very attractive. The chips can be handled with existing equipment, and the fiber is roughly equivalent to low grade hardwood.

Farmers in the Willamette Valley are now being approached by pulp and paper companies to convert valley agricultural lands to hybrid poplar production. While this may initially look very exciting, many questions regarding plant performance on poorly-drained agricultural soils and the economics of production remain to be answered. Growers can easily invest $1000 per acre in the first three years of a 10 year rotation with no guaranteed contract price at harvest.

Advantages:

Propagation is easy and very rapid
Chips fit easily into existing process

Disadvantages:

Economic and market uncertainties

Bamboo (Arundinaria, Dendrocalamus, and Phyllostachys spp.)

Although bamboos have only been recognized as a valuable raw material for pulping since early this century, they now provide pulp for a significant percentage of paper production in India and Asia. Approximately 80% of Indian paper production is from bamboo, primarily Dendrocalamus species. Many Asian mills commonly use bamboo as a source of fiber when other seasonally available fiber sources such as rice straw or sugar cane bagasse are in short supply. Most of these are quite tiny mills, and they are very heavy polluters. The technology for harvesting, transporting, chipping, and pulping bamboos has been well developed. As with other grasses, the high silica content of bamboos can pose significant problems to paper makers.

Unfortunately, a large percentage of the native bamboo stands, particularly in the foothills of the Himalayas, are in much the same condition as our conifer forests, having been depleted after years of intensive cutting. Large-scale efforts are under way in China to improve bamboo productivity with better management and selective harvesting.

Many bamboo species grow well in the mild climate of western Oregon and are generally considered quite invasive. Due to their cold-hardiness and prolific biomass production, members of the genus Phyllostachys will probably form the basis of any large-scale production effort in the Pacific Northwest. These species are generally adapted to regions of high summer rainfall compared to the Pacific Northwest, and their productivity with and without irrigation is unknown. The expense of mass propagation and the extended time required to establish bamboo groves may also be great obstacles to their widespread use in

this region.

Bamboo yield estimates in the literature vary widely from 1/2 to 9 tons per acre per year. Reported yields are difficult to interpret because they are usually not based on standardized management or harvest methods and the growth period before harvest is often not recorded.

Advantages:

Very high quality fiber
Perennial crop
Short rotation with high production per acre
Wide harvest window
Can be stored outside

Disadvantages:

Propagation may be slow and expensive
Some species may not be well adapted to poorly drained soils
High silica

Comparison of Noonday Fibers

The chemical and physical properties of fibers are of critical concern to commercial paper makers. These properties are important not only to the economics of paper making, but a thorough knowledge of their interactions is essential to consistently produce paper with the characteristics required by modern consumers. A comparison of the properties of a number of nonwood fiber sources is presented in Tables 1 and 2.

The fiber dimensions in Table 1 refer not to the gross fiber that might be extracted by pulling a plant apart but to the "ultimate fiber" that is produced when these materials are subjected to chemical pulping. In looking through the fiber dimensions in Table 1 it is immediately apparent that many nonwood materials produce much longer fibers than those found in wood-based pulps. The bast fibers in particular produce very long, thin fibers with high tensile strength. Bamboos have a wide range of fiber dimensions depending on

species.

The most important information in Table 2 is under the column showing the percentage of alpha cellulose in each material. Since paper is made primarily of cellulose, this information is of great interest to paper makers and has a large impact on the economics of paper production. Cotton, of course, is a very pure source of nearly crystalline cellulose and makes excellent paper.

Because of the problems it can cause with chemical recycling, the silica content of raw materials is also important. As the table indicates, wood and bast fibers generally have little or no silica, while grasses, especially rice straw, can have quite high silica content and require great care to avoid problems with process chemistry. Despite this, large amounts of paper are made annually using rice straw.

Bamboo Research at Oregon State University (OSU)

There is currently no formal research underway on bamboo production at OSU. Since any bamboo production research will be a long-term project and resources are limited, it is important to make the best possible choices early if such a project is to have any chance of success. A number of critical factors must be carefully considered in designing experiments to test the commercial viability of bamboo in the Pacific Northwest.

1. **Species selection** is absolutely critical to success. This is especially important considering the large number of bamboo species available. Some possible species selection criteria are listed below.

   Species selection criteria
   - Adapted to PNW
   - Easy to propagate
   - Rapid establishment
   - Early shooting
   - High yield

Table 2. Chemical properties of non-wood fibrous materials.

Fibrous material	cellulose	Alpha cellulose	Lignin %	Pentosan %	Ash %	Silica %
STALK FIBERS						
Straw - rice	43-49	28-36	12-16	23-28	15-20	9-14
-wheat	49-54	29-35	16-21	26-32	4-9	3-7
Canes - sugar	49-62	32-44	19-24	27-32	1.5-5	0.7-3
bamboos	57-66	26-43	21-31	15-26	1.7- 5	1.5-3
BAST FIBERS						
- textile flax tow	76-79	45-68	10-15	6-17	2-5	
- seed flax tow	47	34	23	25	2-5	
SEED HULL FIBERS						
- cotton staple		85-90	3-3.3		1-1.5	<1
WOOD FIBERS						
- conifer	53-62	40-45	26-34	7-14	1	<1
- deciduous	54-61	38-49	23-30	19-26	1	<1

2. **Pulping Tests** should be carried out before production trials begin. There is little point in testing species that are unsuitable for paper production. This can be accomplished with as little as 10 pounds of culm material.

3. **Propagation** methods and the type of propagule used to establish the trials will have a dramatic effect on the rate of establishment and plant productivity. Several possible types of propagules are listed below.

Plant propagation
- Clump divisions
- Young plants
- Rhizomes
- Tissue culture

4. **Location and preparation of the test sites.** Test sites must be identified that are representative of large potential production areas. They must also be prepared using methods comparable to those anticipated for commercial production.

Many other factors should also be considered in conducting these kinds of trials including the use of irrigation and fertilizers as well as comparison of harvest methods and timing. From this brief summary it should be apparent that research into the large-scale commercial potential of bamboo production in the Pacific Northwest is not a trivial undertaking.

Timber Bamboo

Richard A. Haubrich
P.O. Box 640
Springville, CA 93265

Bamboos of the genus *Phyllostachys* can be grown over much of the West Coast of the United States. The best species for pole production should produce large straight poles with fairly thick walls. My choice is *Phyllostachys bambusoides*. *Phyllostachys viridis* culms tend to be zig-zagged and thin walled, *P. nigra 'Henon'* or Henon bamboo doesn't produce the larger diameters and *P. viridis* culms are often bow shaped. Moso bamboo or *Phyllostachys heterocycla pubescens*, the largest of the genus, does not grow well in California; in the Pacific Northwest it often attains only the size of a bush.

Although *P. bambusoides* is said to reach 6 inches in diameter, such culms are extremely rare. In searching the literature on bamboos grown in the U.S. I found only one report (Franceschi, 1908, note 5) of *P. bambusoides* culms greater than 3 inches in diameter. I have never seen one.

Table 1 shows some yields of bamboo poles in the U.S., Japan and China. The largest poles reported in Japan averaged 3.5 inches in diameter. Although the total yearly yield was 490, only 110 of these were greater than 4 inches in diameter (assuming the diameters follow a Gaussian distribution).

Table 1 also gives some yields of culm count and weight for 2 other species, *P. rubromarginata* and *P. glauca* both of which significantly out perform *P. bambusoides* in biomass production. *P. glauca* also produces some fairly large

ameter poles. One should note that the weights given here are for oven dried culms without branches. Culms and branches as harvested weigh twice as much.

Table 1 - Yield of Some Timber Bamboos

LOCATION	SPECIES	AVERAGE DIAMETER INCHES	SINGLE DRY CULM WEIGHT LB	NUMBER OF CULMS/ACRE/YEAR	DRY CULM WEIGHT TONS/ACRE/YEAR
Auburn, AL 1	BAM 2		3	2900	4.4
"	BUB 3		2.4	9870	11.7
Savannah, GA 4	BAM	2	4.9	1760	4.3
Bakersfield, CA 5	BAM	3.25		345	
"	BAM 6	>4		50	
Kyoto, Japan 7	BAM	1.5	3.9	1700	3.3
"	BAM	2	7	890	3.1
"	BAM	3.5	25.3	490	6.2
"	BAM 8	>4		110	
"	BAM	>5		9	
China 9	GLA 10	2.625	15.1	1680	12.7

Key to Table 1 Location and Species Code Numbers.

1. Sturkie, D.G., V.L. Brown and W.J. Watson, 1968. Bamboo Growing in Alabama, Agricultural Experimental Station/Auburn University, Auburn, Alabama, *Bulletin 387*, December 1968. Data taken from Table 2 and Table 3. Annual yields were obtained by dividing the total yields by four, corresponding to a cutting cycle of 4 years. The number of culms is for those longer than 15 feet. Culm weight excludes branches which are 21% of the total dry weight. One might infer from the low single culm weight that the diameters averaged less than 1.5 inches.

2. *Phyllostachys bambusoides*

3. *Phyllostachys rubromarginata*. The number of culms is for those longer than 15 feet.

4. Adamson, W.C., G.A. White, H.T. DeRigo and W.O. Hawley, 1978. Bamboo Production Research at Savannah, Georgia, 1956-77, Agricultural Research Service, U.S. Department of Agriculture, ARS-S-176, March 1978.

The numbers given are my computed overall averages for 849 culms originating in different years with cutting cycles of 3, 4, 5, 6, and 7 years. The average diameter of smaller groups of culms (from 10 to 70) originating and cut in separate years ranged from 1.6 to 2.5 inches.

5. Franceschi, F., 1908. Bamboos in California, *Pacific Garden*, Summer, 1908.

6. The yield of culms per acre per year greater than 4 inches in diameter based on a 4 year cutting cycle.

7. Watanabe, M. and T. Aoki, 1990. Some Productive Aspects of *Phyllostachys bambusoides* Stands, *Bamboo Journal* No. 8, pp 1-8. I have adjusted all the numbers to reflect a 4 year cutting cycle.

Raising the Dragon: Bamboo Agro-Forestry in Vietnam

Simon Henderson
30816 3rd Ave. N.E.
Stanwood, WA 98292

"Something in the very size of bamboo clamors for a bamboo farm".
--David Farrelly, The Book of Bamboo

In the Autumn of 1993 I was invited by Bamboo International Corporation to travel to Vietnam to research the potential of bamboo in an agro-forestry complex. The focus of my mission was to investigate the culture of sympodial (clumping) bamboo for plybamboo parquet flooring, utility poles, and craft items. From my own training in permaculture--which looks to traditional agriculture as models of sustainability--I knew that I would find an abundance of resources on the ground, down on the farm.

Indeed, with a population of 72 million, approximately 50 million--or 70%--of the Vietnamese people earn their living from agriculture. Vietnam has an overall population density of 200 persons per square mile, one of the world's highest for an agricultural country. Finding a farmer is not a difficult task.

My bamboo research took me primarily to areas in three provinces of the former South Vietnam with diverse climates and distinct landscape profiles. These were the province of Song Be, in South Central Vietnam, a short distance northeast of Ho Chi Minh City (Saigon), Dak Lak Province located in the Remote Central Highlands with the strategic city of Boun Ma Thout as its provincial capital, and Khanh Hoa Province with it's coastal fishing port of Nha Trang.

Vietnamese describe their country geographically as resembling a bamboo pole supporting a basket of rice on each end. The country is S-shaped, broad in the north and south and very narrow in the center, where at one point it is only 50 km wide. In Vietnam, as in all Asian cultures, bamboo has become an anthropomorphic metaphor for utility and resilience. It's predominance in every form of construction and craft medium--particularly benefited as a result of the 20 year American trade embargo--has created a medium expressed in its fullest cultural flowering. Vietnamese simply refer to bamboo as "the brother".

As an American in Vietnam, I arrived with preconceived notions as to how I would be received, not to mention a hefty burden of emotional baggage from the sixties. (I did not serve in the Vietnam War, but I watched it on T.V.) Instead, I was overwhelmed by the generosity and graciousness of Vietnamese people. The predominate attitude is to get on with nation building after 60 years of war. Although there are still obvious resentments between the North and the South Vietnamese--"Me no V.C.; America number one!"--the phrase "national reconciliation" is often voiced. I was welcomed by Buddhist monks and Communist Party officials alike.

Apocalypse Then

However, no discussion of current Vietnamese agro-forestry practices, nor any valid ecosystems research can ignore the lingering chemical legacy of the war. The chemical herbicide, Agent Orange, was used as part of the massive defoliation program to destroy jungle cover, crops and other vegetation (including 36% of the coastal mangrove forests). Approximately 107 million pounds of herbicide were applied over about 6 million square miles.

Compounding this delirious drama of ecocide is the capacity of chemicals to potentate in the environment. That is, the environment can serve the same purpose as a test tube; chemicals can interact. Potentiation is a chemical reaction in the environment that could increase the toxicity of herbicides and pesticides, creating greater toxic contamination

The long-term results of this onslaught have been devastating. The lush tropical forests have not grown back, fisheries (even those in coastal waters) remain depleted in both variety and productivity, wildlife populations have not

recovered, and crop land productivity is still below its prewar levels. An interesting adjunct to the ecological imperialism of the war years was the appearance of the herbaceous nitrogen-fixing plant, busit, or "V.C. Grass" as it has come to be called in the former South Vietnam, an introduction from the north, which came "on the soles of the boots of the Viet Cong. An American botanical legacy, known locally as "American Grass", has replaced nearly 20,000 square miles of forest and farmland. This tough weed prevents young trees from receiving enough light to survive, as it can reach 12 feet tall with serrated edges that shred flesh and clothing. Also known as Elephant Grass, it has pioneered in many highland areas where the former rain forest cover had been removed by Agent Orange. Elephants in these regions, useful for transport, were also attacked from the air with bombs and napalm out of fear that the V.C. were using them to bring in arms.

Back to the Future

I arrived in Ho Chi Minh City--though everyone still calls it Saigon--at midnight. My luggage did not arrive with my flight; in fact, it never arrived. After October in Seattle, I began a rapid meltdown in the 90 degree heat with 80% humidity. New Levis and one-size-too-small-Hightec-hightops safari boots, with a long-sleeved black and white cow print cowboy shirt completed the ensemble, which for 6 weeks, I would come to loathe.

"You'11 get used to the heat as soon as your blood thins" giggled my driver, obviously used to counseling large American tourists with seriously flawed thermostats.

"How long does that take", I gasped.

"Oh, maybe three, four day" The driver hurtled at 50 mph through an amoeba of 2,000,000 motorbikes. Young lovers, out for an cool evening ride on his and hers motorbikes, careening along--and holding hands across a chasm of four to six feet--at 30 mph through the most unbelievable traffic in the world.

All of Saigon comes out at night. "Evening" doesn't even begin until 11:00 p.m. This "cool" part of the day, is in the low 90's. Restaurants are full and spill out onto the sidewalk. Kaoroke bars still popularize American 60's hits, like Martha and the Vandellas (from the dreaming mythology of the wartime) while

the braying of acned teenagers lipsynching to Lycon de Twist completes the sound effect of other dining establishments. Elite endangered species restaurants feature pick-out-your-own anteater, python, or monkey for brazing, while Michael Jackson look-alikes manlike across stages with backdrops of Lawrence Welk style bubble machines. I found myself pondering how a communist country in reconstruction, after half a century of endless war, could possibly find the luxury of time to spend half the night, dressed-to-kill, riding in mobs on motorbikes. This is in a country with an average per capita income of $200 per year. This was the first on a list of many enigmas that I was to encounter. The East meets West Paradox thing. And Saigon boogies on.

Bac Ho is Watching You

Uncle Ba floated across the dining hall, tall as a child, barely legged but spry. His crew cut white hair and diaphanous white cotton shirt gave the appearance of some ghostly sage. The room was dark and humid. In the corner a rusting 1949 Peugeot sat cobwebbed in a surreal tropical cocoon of dust and oil. With the fall of Saigon in April 1975, all artifacts of a former bourgeois lifestyle were hidden away so that now all over the city a great relic museum of the fruits of a colonial legacy lay mouldering, out of the sight: even the informers have forgotten. Dim memories from a time of pain.

He held his hands prayer-like, palm to palm, in the Buddhist form of greeting. We bowed together. Our eyes sought out one another across chasms of culture.

His glances were drawn to the Maori spirals tattooed across my cheekbones and to the four dots placed above them by the Berber shaman 25 years before in Morocco. Ba's eyes began to glow, as if he had just awakened. A smile grew like a furrowed garden across his face and he reached up with a small, aristocratic finger to gently trace the tattoos on my cheeks.

"He speaks French, Simon: "Tell him about your tattoos. We call him Ba, Uncle Ba. We Vietnamese call all old people Ba. We call Ho Chi Minh, Bac Ho, Uncle Ho."

Ba began to sputter in rusted French, unspoken in 40 years. His fingers still

touched and caressed my face. "C'est ca, c'est vraiment ca. La numero quatre."

He turned to a blackboard on the kitchen wall and began to elaborate. "In the Buddhist tradition, the number four represents the Four Noble Truths. The sacred swastika, as the halo of Buddha, is seen in all the pagodas. The spiral is the manifestation of the heart essence, lavrais coeur, the spiral journey of life is a journey inward, toward the heart. Toward the heart of illumination."

Later that week we visited the district police headquarters in Boun Ma Thout to procure my travel permit for the Remote Central Highlands. It was a formal ritual of question asking and a "gift" exchange of Marlboro cigarettes. Red paper banners embossed with the communist icon of the hammer and sickle hung limp on the dingy wall behind the district police chief, where twin photos of Ho Chi Minh and Nicholi Lenin gazed out from a rapidly disappearing world. I imagined Ho Chi Minh's thoughts as he witnessed the first American returning to the Highlands after twenty years, an old hippie gardener at that. With a waning smile, his photo spoke: "Bac Ho is watching you"...

The Remote Central Highlands, home to more than 30 distinct ethnic groups of tribal peoples, became the focus of my journey. It was also here, near the provincial capital of Buon Ma Thout that my host, Quy Nguyen, with his American business partner, Doug Lewis, began a small bamboo products factory.

Boun Ma Thout is situated at an elevation of 1,480 ft. at the edge of the Son Mountain Range, which sprawls like a sleeping dragon between the Central Highlands and the Cambodian border. Before WW II, the city was renowned as a departure point for big game hunters. The western perimeter of the outlying settlements is bordered by the Cau Serepok River, the great aquatic highway of the highlands.

As the coco palm and rice padi culture of the coastal plain gave way to the bambooed slopes and remnant rain forest of the approaching highlands, I couldn't help compare the similarities between the Central Highlands and the Guatamalan Altiplano (high plain) region near Lake Atitlan. Aside from the native trees, the cultivated and naturalized plant species index could read the same for both regions, though vastly separated by 12,000 miles of ocean. My

running index--observed from a rapidly moving automobile in Vietnam--reads something like: Cassava (manoic), ginger, peanuts, yams and sweet potatoes, pigeon peas, okra, corn, squash, cucurbits of untold varieties, bananas, squash, sugar cane, pineapple, lechee nut, papayas, cabbage, beans, mustard greens, tamarinds, mangoes, Chinese apples, hops, black pepper, cardamom, coco palm, juju fruit, guava, star fruit, mizuna, taro root, pomegranate, avocados, passion fruit, betel nut palm, jack fruit, breadfruit, coffee, grapefruit, water spinach, water chestnuts, lotus and an endless array of nitrogen fixing trees. The backbone of this botanical cornucopia is the diverse and ubiquitous bamboo.

The Bund/Padi Bamboo Polyculture

I began to recognize patterns of Vietnamese agriculture intricately interwoven with the culture of bamboo, the rice padi, and the intensive home garden system. In my quest for The Quintessential Vietnamese Permaculture, from which I could extract an idealized model, I initially overlooked the tenet that each site is unique, and perhaps, that there were cultural edicts for which I had no filters. From the deep well of my permaculture teachings came the sage voice of Max Lindeggar, "Ask what it is that you do not know".

My enchantment with observations on bamboo and its intimate relationship with Vietnamese culture blinded my larger perception of a traditional systems design, known as "VAC"--revealed later in this paper--as a polycultural approach to food and fiber production that encompasses the entire small farm ecosystem. I had begun my investigation with analytical observations of each element in the homestead composite: why is this thing here, and what other function(s) does it support? It was too grand to take it all in at first: The garden supports the pigs and poultry, which support the micro-livestock in aquaculture, which supports the gardens and food forest, which, in turn supports the farm family, which in turn, support themselves!

It was a conversation with a policeman/farmer on the outskirts of Boun Ma Thout that opened my range finder from 180 to 360 degrees. "What is the strategy for placing your pond right in front of the house?" My thinking of course, was that it seemed a more logical place for intensive, zone one gardening.

He responded: "I'm a traffic cop all day in the city. Noise, pollution. It's crazy work. When I come home I like to sit on my front porch and fish in my pond, and catch my dinner. Doesn't that make sense? Besides, the local kiln buys the clay from peoples' yards and digs it out, from which they make roofing tiles. Then there's a big hole that fills up in the rainy season, and voila, you've got a pond that you got paid for and that you didn't have to dig!" Now, that's permaculture.

The farmer stocked his pond with a variety of carp, catfish and perch. Frequently, when the Monsoon season arrives, there can be extensive flooding across the plains near the Cau Serepok River, flushing out the local ponds of captive fish. In their place river fish (and sometimes turtles, pythons or crocodiles!) are deposited, making for a new menu. The farmer was stoic about the affects of the annual rainy season, accepting the new abundance with gratitude. "Now my wife and I will have to learn new recipes". Going with the flow, so to speak. Feral aquaculture.

Around the edge of the pond shimmered an emerald mantle of aquatic and sub-aquatic species including Lotus, water chestnuts, watercress, water spinach and Taro, with Lantana camara on the bank. Planted into the flat berms-- or" bunds"-which separate padis from ponds, etc., were an endless variety of fruit trees, vegetables and giant grasses--bamboos, sugar cane, and lemon grass, occasionally, corn (Fig. A-4). Truly a tropical food forest/orchard, defined by the bunds, much like a hedgerow, and utilizing the same water and nutrient cycling principles familiar to *chinampas*. A stacked polyculture of vegetables and tubers--ginger, manoic (cassava), spinach, yams and sweet potatoes--of fruit shrubs and trees--pomegranate, banana, papaya, betel nut and coco palms--and giant grasses, as detailed above.

Bat-attracting Dung Caw trees are commonly planted near the house. They bear nectar and fruit--which bats relish--and are occasionally caught with hand nets, providing a Vietnamese delicacy. Frog catchers can be seen in the evening, moving cautiously through the lotus ponds with long hooked bamboo poles extended--like a praying mantis (fig. A-1). Vietnamese farmers also take great pride in the construction of their elaborate dovecotes--for pigeons--there is fierce competition in some areas of the countryside to attract another

farmer's flock to one's own dovecote. The phosphate rich manures are collected and used in the garden. The farm stead python hutch is another common feature, wherein a large python is fattened up on rodents, etc., which are caught by the children. Eventually the python is butchered for a special feast. There were many cultural filters I needed to brush aside in my assessment of viable Vietnamese nutritional resources.

Vining plants compliment this assembly, especially near a homestead or village site, where they are often seen lofted into ascendant gardens by clumps of bamboo. Cucurbits, such as Luffa (Luffa acutangula) are a common vine, twining up into bamboo groves or sometimes onto trellises near homes or even trellises over ponds, creating shade for fish and prawn cultivation.

> *In Asia, the Luffa's young fruits are eaten raw in salads, boiled, steamed, stuffed, stir-fried, coated with batter and fried, pickled, cooked with coconut milk or added to soups, stews or curries. Young leaves may be eaten in salads or cooked as greens. Flowers and flower buds are dipped in batter and sauteed. Mature seeds are roasted, salted, and eaten as a snack.* -- from Cornucopia: A Source Book of Edible Plants.

In North America, the Luffa is known as the "vegetable sponge", and it's culinary uses are totally overlooked. I was back in the U.S. before I learned that the Luffa is an important component of Vietnamese diet. My cultural filters had only registered: Luffa Vine: Only useful as sponges. So why is it growing on every house, storefront, trellis, and up every bamboo groove in Vietnam?: "Ask what it is that you do not know".

Under the Bamboo Tree

Under the bamboo bamboo bamboo
Under the bamboo tree Two live as one
One live as two
Two live as three Under the bam
Under the boo
Under the bamboo tree

Where the Gauguin maids
in their banyan shades
Wear palmleaf drapery
Under the bam
Under the boo
Under the bamboo tree

Tell me in what part of the wood
Do you want to flirt with me?
Under the breadfruit, banyan, palmleaf
Or under the bamboo tree?
Any old tree will do for me
Any old wood is just as good
Any old isle is just my style
Any fresh egg
Any fresh egg
And the sound of the coral sea.

--T.S. Elliot

In his playfully luxurious, though mistaken, reference to the bamboo "tree", T.S. Elliot has unknowingly placed bamboo, the giant grass, in its proper context as a key component in any tropical agro-forestry complex..

The permaculture concept of "guilds", as defined by Bill Mollison:

> ..is a harmonious assembly of species clustered around a central element (plant or animal). This assembly acts in relation to the element to assist its health, aid our work in management, or buffer adverse environmental effects.
>
> In the natural world, we may often notice assemblies of plants or animals of different species that nevertheless occur together over their range. Closer examination of such mixed assemblies often reveals a set of mutual benefits that arise from such convivial togetherness. These benefits offer help or protection to the whole assembly. When we design plant guilds, as we always try to do in a polyculture, we try to maximize the benefits of each species to the

> others. We can also add factors of convenience to ourselves, or which save us inputs of fertilizer or pesticides.
>
> --Permaculture Activist
> Volume V, No. 2, May 1989

In recognizing bamboo's utility as a premiere element in a guild assembly, I was foremost challenged by contradictive--often paradoxical--data gleaned from observations of captive monocrop bamboo (in plantations) vs. the patterned polycultures of traditional homesteads and villages (bund/padi polyculture) and observation of bamboo in both the natural forest ecosystem--as an under story species--and in vast tracts of tropical clearcuts where it predominates as a pioneer. Understanding *what* I was seeing as well as *when* I was seeing it--a shuttered window of a niche in time and space--was a profoundly confusing (and yet revealing) task for this permaculture designer with a predominately temperate landscape portfolio and the inherit limiting filters. At last, I began to methodically question my assumptions. I further posed yet another useful hypothesis: *Where* was I seeing it, in geography and climate. This route of principle review and assumption interrogation led me to a myriad of new revelations in my observation (fig. A-2).

Let's follow the process:

1.) Know *what* you are seeing: Visits to "captive" bamboo plantations brought perplexed inquiries regarding the method of cultivation, which appeared to be extremely labor intensive; tidy and concentric clumps, on six to eight foot centers, with the average homestead plantation on .5 to one hectare. After several plantation visits it dawned on me that I was viewing *sympodial* (clumping) bamboo, native to the tropics. My experience had always been with *monopodial* (running) bamboo of more temperate landscapes, legendary in it's ability to spread rampantly in all directions, often devouring urban landscapes. Thus sympodial bamboo ideally suites captive cultivation, growing in a predictable clumping pattern that facilitates selective harvesting and maintenance.

2.) Know *when* and *where* you are: In the foothills approaching the Remote Central Highlands I viewed vast tracts of bamboo covering thousands of acres. My initial observation registered a monocrop invasion by rampant bamboo. This too, was an erroneous assumption based on my familiarity with the

growth pattern of monopodial timber bamboo in northern temperate landscapes. An inquiry of local farmers revealed that the forest had been recently logged for its tropical hardwoods. It was much more satisfying when I realized that I was seeing bamboo as a successional pioneer in stage one forest regeneration. David Farrelly refers to bamboo's role in forest succession where it "functions as a healing scab (or 'eco-scab') for gashes on the planet. It has already swarmed tall and green over gutted areas of Vietnam defoliated during the war there and appears to have flourished, historically, in the wake of man's shifting agriculture throughout the East." In this role, bamboo stabilizes and rebuilds the topsoil until further forest regeneration is possible, much the same as the maligned blackberry functions in clearcuts of the Pacific Northwest.

Bamboo, in its featured role as a central element in this tropical plant assembly, inherently determines the success and diversity potential of many Vietnamese built landscape profiles. With it's rapidly escalating economic potential in the world market for flooring material--as well as pulp and paper production--bamboo is now poised on the threshold of being recognized as the world's most important, annually renewable, plant fiber material. As important, it can be a key to break the vicious cycle of poverty in Asia and other tropical regions of the developing world.

The Conceptualized Plantation

"Agro-forestry is a sustainable management system for land that increases overall production, combines agricultural crops, and forest plants and/or animals simultaneously or sequentially (in succession), and applies management practices that are compatible with the cultural patterns of the local population. Trees are the dominant natural vegetation in most of the tropics, and with few exceptions must remain so if the land is to be used for the greatest benefit of man." (Bene, *Trees, Food and People: Land Management in the Tropics*, 1977)

The proposed 1000 acre site in Song Be Province would be an integrated composite of bamboo silvaculture, agro-forestry, village settlement, intensive aquaculture and high yield garden systems, with light manufacturing on site. (See fig. A4). Multiple manufactured products would include ply-bamboo flooring and utility poles for export, with baskets and craft items for local,

domestic and export markets. Potential yields from intensive aquaculture systems would include high value tilipia, frog and eel leather processed into value-added products for export and a multitude of fish--particularly carp--for homestead harvest. Pork, fowl and their eggs would compliment food production for local market and village consumption.

The variety of fruits, nuts, vegetables, legumes and tubers from the food forest/intensive garden systems would supply a further surplus for the local market place.

Methane digesters associated with pig farming would provide on site gas for cooking. The high yields from the integrated agro-forestry system would be coppiced for local firewood sales, harvested for timber and coppice from nitrogen fixing tree species used as mulch around bamboo clumps and food forest trees. Tropical hardwoods would be managed for long term yield on 20 to 60 year cycles, with coffee, vanilla, cocoa, and pepper grown in under story (or at edge) for perennial and annual crops.

An obvious benefit of this system would be it's high degree of self-sufficiency, efficiency of resource management and right livelihood for resident population via on-site manufacture. There would be less strain on local forest resources for firewood and timber.

Resurrecting the VAC Tradition

For the past 1000 years, traditional Vietnamese farmers have elaborated an integrative polycultural approach to small scale food production known as "**VAC**", an acronym comprised of three disciplines--'**Vuon**', the garden or orchard; '**Ao**', the fish pond; and '**Chuong**', animal housing for pigs and poultry. Together they make for a highly intensive method of small scale farming that makes optimal use of land, water and the sun. Plants are used for food, for fiber, and for fuel and all waste products are passed into the production cycle.

"VAC incomes constitute 70 to 90 percent of farmers' incomes and annual incomes of farmers utilizing the VAC system are three to five times higher (sometimes as much as ten times) than that derived in the same area from

domestic and export markets. Potential yields from intensive aquaculture systems would include high value tilipia, frog and eel leather processed into value-added products for export and a multitude of fish--particularly carp--for homestead harvest. Pork, fowl and their eggs would compliment food production for local market and village consumption.

The variety of fruits, nuts, vegetables, legumes and tubers from the food forest/intensive garden systems would supply a further surplus for the local market place.

Methane digesters associated with pig farming would provide on site gas for cooking. The high yields from the integrated agro-forestry system would be coppiced for local firewood sales, harvested for timber and coppice from nitrogen fixing tree species used as mulch around bamboo clumps and food forest trees. Tropical hardwoods would be managed for long term yield on 20 to 60 year cycles, with coffee, vanilla, cocoa, and pepper grown in under story (or at edge) for perennial and annual crops.

An obvious benefit of this system would be it's high degree of self-sufficiency, efficiency of resource management and right livelihood for resident population via on-site manufacture. There would be less strain on local forest resources for firewood and timber.

Resurrecting the VAC Tradition

For the past 1000 years, traditional Vietnamese farmers have elaborated an integrative polycultural approach to small scale food production known as "**VAC**", an acronym comprised of three disciplines--'**Vuon**', the garden or orchard; '**Ao**', the fish pond; and '**Chuong**', animal housing for pigs and poultry. Together they make for a highly intensive method of small scale farming that makes optimal use of land, water and the sun. Plants are used for food, for fiber, and for fuel and all waste products are passed into the production cycle.

"VAC incomes constitute 70 to 90 percent of farmers' incomes and annual incomes of farmers utilizing the VAC system are three to five times higher (sometimes as much as ten times) than that derived in the same area from

growing two rice crops a year" (See article, "Vietnam--The Way it Was", by Rosemary Morrow, Earth Garden Journal, Winter Issue, Number 88, 1994, Trentham, 3458, Australia)

Another innovative traditional system that has had some phenomenal success in China--and more recently, with modifications, in Vietnam-- is the **Dike Pond System** introduced by Dr. George Chan, an environmental consultant, renown in Asia for his work in aquaculture systems.

Dr. Chan first encountered the 500 year old dike pond systems in the Pearl River delta area of China. It covers an area of 80,000 hectares and "achieves one of the highest productivity per unit surfaces of land in the world--all without nonrenewable inputs from outside. The system integrates livestock, aquaculture and agriculture, using the residues of each process as input for the next. (See article, Lessons from China--the work of George Chan, by Andrew Bodlovich, Permaculture International Journal, Issue Number 51, 1994)

Most important, and different from Vietnamese pond building techniques, is the creation of an unusually deep fish pond, with a depth of two and a half to three meters. This allows for several varieties of fish to feed at varying depths and optimizes the growth potential for various plankton. The spoils from the pond excavation are piled to form raised dikes around the pond perimeters, usually several meters wide, where crops are grown or livestock can range, and are safe from floods, which are common in deltaic landscapes. Farmers can access their dike ponds by boat, along well designed canals from their villages.

The highly mineralized pond water is used to irrigate and fertilize a large variety of crops on the dikes (bunds) without the need for chemical fertilizers or pesticides. The only inputs to the pond are freshly cut tall grass from the pond edge and manure from livestock. Two meter tall grass is cut and thrown into the pond and is consumed by grass carp.

The grass carp has its teeth in its throat and relatively short intestines and swallows the blades of grass whole. You see it going into their mouth and then

see it coming out the other end too! The common carp eats the semi-digested grass excreted by the grass carp.

Every now and then the common carp tires of eating grass carp excreta, and so swims to the bottom of the pond to eat bacteria. All other fish species remain at a particular water depth in the pond; the common carp is the only fish in the system that does not remain at one particular level. By swimming from the top of the pond to the bottom the common carp aerates the water at the bottom of the pond. Even in a three meter deep pond, no additional aeration is required--the diving and surfacing of the common carp provides sufficient aeration.

In all, six varieties of carp, each inhabiting a particular water depth and consuming different food types, co-exist in the pond. Silver carp feed on phytoplankton in the shallower levels where sunlight can easily penetrate. Bighead carp feed on benthoplankton below the silver carp. Towards the bottom of the pond black carp feed on the benthoplankton, and on the pond bottom, mud carp feed on detritus and food remains filtering down from the higher levels.

Many aquaculture systems use shallower ponds with a depth of around one to one and and a half meters, based on the assumption that most biological activity takes place where sunlight can penetrate, and hence autotrophic organisms are abundant. In the Chinese system, the deeper pond allows for the growth of heterotrophic organisms (not requiring sunlight) for other fish species to feed on. This can result in up to ten tons of additional fish yield per hectare annually.

Autotropic organisms grow by photosynthesis at the top of the pond using solar energy and atmospheric carbon dioxide. Heterotrophic organisms grow deeper in the pond using organic matter present as source of both energy and carbon. (Ibid)

Improvements to the System

After studying the ecological principles of the traditional dike pond system, George Chan drew on his own training and experience to enhance the

traditional system and adapt the basic principles to a variety of situations.

A biogas digester and algae basins were added to the system to treat manure before it entered the pond. These processes convert up to 90% of polluting organic matter into minerals suitable for use as fertilizer, making the system more aesthetic and hygienic than the traditional system.

To establish such systems in other parts of the world, suitable local species of fish need to be identified to fill each niche in the system. George Chan is encouraging further research in this area.

Using Dr. Chan's strategies for integrated farming projects with a potential of high value exports we can add considerably to the Vietnamese farmer's annual income.

A resource of significant importance to the proposed project is the proximity to the University of Agriculture and Forestry (UAF) in Thu Duc, north of Ho Chi Minh City, within a few kilometers of Tinh Song Be. It is in association with this university that Professor Chan has been developing the New Strategy for Rural Development.

It would be highly recommended to use resources at UAF to identify the particular bamboo species used in plybamboo manufacture, pole production, etc. Once the correct nomenclature is established, a cultivation program can indicate spacing configurations within the groves, determine optimum fertilization and water requirements and project of realistic yields.

Fortunately, once a species is identified, there exists a large body of documented information on most of the commercially viable species cultivated throughout Asia. (See Tables in Bamboo Culture and Research Abstracts in references).

The layout of the bamboo plantation can include a variety of management and design disciplines suited to slope, landscape features, climatic types, planting patterns ("horseshoe" clumps vs grids), access by proximity to water resources including chinampas, swales, or bund polyculture and flow-down from

aquaculture ponds (See figure A4). Planting design would depend upon the machinery and labor available as well as harvest strategies.

Structural forests, for firewood production, coppiced for mulch, timber crop, polewood, hedgerows, long term fine timbers, etc, would be integrated with pure stands of bamboo. Approximately one- quarter (250 acres) of the 1000 acre site should be leguminous trees. These could include: Albizia spp. and Acacia spp. (A. fimbriata, A. auriculiformis, A. longifolia), Inga edulis, Cassia multijuga, C. spectabilis, C. fistula and spp., and Sesbania grandiflora (See Table 1). The cultivation of the classic nitrogen fixing tree species of the tropics--Casurina and Leucaena--is already widespread throughout Vietnam and would also be highly recommended for agro-forestry cultivation.

In his book, My Life My Trees, the visionary forester, Richard St. Barbe Baker, makes the critical observation in plant symbiosis (also known as guild associations in permaculture) while researching sustainable development of mahogany rain forests in Nigeria, he states: "Each mahogany is surrounded by numerous trees belonging to other families, amongst which is that important family of Leguminosae--the soil improvers. These I have observed to be good nurse trees for the mahoganies. The more important species of mahogany require the services of a succession of nurse trees throughout their life to bring them to perfection. Some of these provide just sufficient competition to coax the young sapling upwards. Others do their work in secret under the surface of the soil, interlacing the roots, a sort of symbiosis, like mycelium, which starts as an independent web-like growth, surrounds the sheath of plant rootlets and prepares food that can be assimilated by the growing trees."

In the tropics and subtropics, nutrients are cycled through the vegetation (biomass), not the soil, hence the emphasis on mass plantings and stacking of vegetation layers. In association with bamboo, many of the legumes can be coppiced and used as nitrogen-rich mulch around bamboo clumps. On site waste will be managed for resource, including the by-product from bamboo manufacture--as it is in the rest of Vietnam--as pulp for paper manufacture.

A site on 1,000 acres, incorporating the aforementioned concepts, could provide a livelihood for up to a 300 people in a residential population, sited in 3 to 4 traditional hamlets. An on-site population has numerous benefits,

including the observed tendency for Vietnamese to harvest bamboo from any unpopulated landscape.

There may be significant benefits to this project to become allied with the New Strategy for Rural Development. It may also be counterproductive, as it is a Government run program. The program strives to put impoverished small farm families on 0.5 or one-hectare parcels for reclamation of millions of hectares of marginal land in the Saigon River Delta. It appears that there is about to be a large-scale rural migration to the Delta region, and that is something significant to take into account.

Summary

The past decade has seen an increasing array of documented research on bamboo culture in those areas of the world traditionally associated with bamboo as construction and craft medium, but also as integrated icons of poetry, diet, philosophy, religion and landscape mythology.

From China to Indonesia: from India to the Philippines, new and old techniques have been married. New markets and new products have been explored, all with an eye to the knowledge that bamboo is the most diverse, useful and abundantly renewable plant material on the planet.

The millenias of human exploitative and resource extractive dominance in world view are at an end. The new models strain to be realized, through the efforts of small groups of individuals around the planet with vision and common sense. There can be no other acceptable Ethic: Repair the Earth, Care for the People, Limit Needs and Reinvest in the Future. Although the problems are large and complex, the solutions are embarrassingly simple. Bamboo is one of these solutions.

Our Peugeot clattered into Song Be where we would spend the evening before continuing our mob tour the next morning of yet another bamboo plantation and factory site, invariably, by way of six roadside restaurants.

We turned onto the main street and were immediately engulfed in a large Buddhist celebration. Saffron robed nuns and brown robed monks were queued

in rows waiting to enter the Pagoda. Tables were set up in the courtyard where townspeople mounded a rainbow of entrees and saffron colored vegetarian dishes. These would be eaten after the ceremony I was told. Children ran quietly amok, or until they saw us. The usual hoard of staring squads surrounded our car to catch a glimpse of The Giant American. Maybe pet my arm a bit, since body hair is extremely uncommon in Vietnam. Or for good luck, a quick jab in my stomach (which I was reassured by my guides, was for good luck and abundance).

The three Nyguen brothers left me in the car to find out more about the event-in-progress. After three weeks in the car, looking for the world like a living crash test dummy, I slipped into my gibbering-tourist-with-ten-words-in-Vietnamese syndrome which I chanted like a manic koan: "How are you I like Vietnam What are you looking at?" This would invariably melt the ice, and then the cacophony would begin: "Where your name? What is you from? America numbah one! U.S.A.--numbah one!"

Every Vietnamese kid also had ten words in English which they creatively grafted into a variety of sentence structures.

Quy finally returned, announcing that the Most Venerable Buddhist Patriarch would be reconsecrating the Song Be Pagoda this very hour, and that we had been invited to attend the ceremony as honored guests. This was something that was done every hundred years or so, and therefore a Big Event.

Inside the pagoda, chairs were brought for us and I was conveniently placed behind a large stone column so that my field of vision seemingly encompassed a surreal diorama of the Acropolis interfaced with Lhasa and bald monks. The nuns also had shaved heads and lined the far side of the Pagoda. Everyone in the Temple was bald and hairless, draped in fabric and androgynous, except for me.

I wore thongs, three sizes too small, polyester khaki shorts and my trademark black and white Holstein print cowboy shirt. My trademark, because it was the only shirt that I owned, the airlines having lost my luggage (It had been sent to Mexico, then China). Go figure. It was a gaggle of unfair fates that endlessly thrust me into wondrous cultural exchanges with the most embarrassingly Ugly

American wardrobe. It was a leveling event for my ego. Reverse refugee syndrome. Revenge of the boat people, I decided.

Inappropriate as I chronically appeared, my hosts insisted that I meet religious leaders, government officials, investment bankers and the like. There were just no clothes to purchase in Vietnam for a foreigner of my girth and height. Size 12 sandals actually fit size 8 feet. I suffered loudly. My Eddie Bauer shoulder bag languished somewhere, thousands of miles to the north, in the land of the mandarins, chocked full of jungle-savvy cotton wear, bug repellents, and shoes that really fit! Mostly, though, I obsessed on the imagined state of decomposition of the smoked salmon which I had purchased at the Pike Street Market in Seattle on the day of my departure. Wedged in between polished cotton slacks and a black silk long-sleeved Ralph Lauren formal wear shirt (Viet Cong sheik). It just wasn't gonna happen.

The oratory of reconsecration droned on for two hours. I understood nothing. The patriarch's secretary gave the definitive presentation, with everyone clapping frequently, as he detailed the modest progressions, and noteworthy achievements of the local diocese for the past 800 years.

The 90-year old patriarch listened serenely as the hallmarks of his reign were elucidated. So serenely, in fact, that he would begin to list precariously to the side of his dias. His eyes closed in slumber. His personal secretary, Thich Thien Duyen, would reach over to gently prop him upright, and to occasionally readjust the Patriarch's hearing aid, at which time his eyes would pop open with a start.

Merciful as Buddha, the ceremony finally ended, and Quy and his brothers drove the Patriarch with his entourage back to his home pagoda, outside Song Be. They left me behind to feast with the village and the nuns. Suddenly feeling giddy, with no one who spoke English, I began to sing twangy country and western songs. "Your Cheatin' Heart" by Hank Williams, seemed to enthrall the entire community, and everyone sat on the ground and smiled compassionately, eating from bowls of saffron colored food, like a surreal county fair in the heartland of America; without potato salad.

Eventually, Quy returned and said that we had been invited to have tea and a private audience with the Patriarch. In his home pagoda he relaxed and

discussed the world at large.

The Patriarch's secretary addressed me, "If you Americans have returned to Vietnam to help in its reconstruction, we welcome you with open arms. This time I see you come with cameras, not guns, and this is good. If you really come to help us live better lives, I ask that you find a way to remove these poisons (Dioxins, agent Orange) from our land. For it seems that they will remain here forever . Tell the Dow people that they left something here in the war and they need to come clean up their mess."

Then the patriarch, lighting a Marlboro, roused to join the conversation: "Prevalent throughout Vietnam we have the twin icons, the phoenix and the dragon, representing the duality of male and female, yin and yang. And like these creatures, Vietnam rises and is reborn from the ashes our past, transformed--like the dragon--in the deep lair of it's own psyche. Come, I will show you."

We followed Him into the altar room of the Pagoda. A large Buddha sat smiling on the altar, with an electric suvastika, like a neon halo, rotating rapidly behind his head.

"The four pathways teach many things. You must know this." He reached up into a grotto of the altar and brought down a small white alabaster Buddha. "Please take this home with you. Buddha will help you and watch over you."

Table 1

Nitrogen Fixing Trees of Vietnam

Binomial nomenclature:	**Vietnamese:**
Casuarina equisetifolia	Phi Lao
Cassia fistula	Muong Hoang Yen
Cassia javanica	Muong Hoa Dao
Cassia siamea	Muong Den
Gleditsia australis	Bo Ket
Tamarindus indica	Me

Dalbergia balansae	Trac Vang
Dalbergia bariaensis	Cam Lai Ba Ria
Dalbergia cochinchinensis	Cam Lai Nam Bo
Dalbergia hupeana var. Laccifera	Co Khet
Dalbergia mammosa	Cam Lai Vu
Dalbergia nigrescens	Cam Lai Den
Dalbergia tonkinensis	Trac Thoi
Pterocarpus macrocarpus	Giang Huong Qua To
Pterocarpus pedatus	Giang Huong
Sesbania grandiflora	So Dua
Acacia auriculiformis	Ho Phu Trinh Nu
Acacia confusa	Tuong Tu
Albezia chinesis	Song Ran
Albizzia falcatarialpin	Ipin
Albizzia lucida	Ban Xe
Albizzia odoratissima	Hop Hoan Thom
Albizzia procera	Muong Xanth
Leucaena leucocephala	Keo Dau
Pithecelobium dulce	Me Keo

BAMBOO CULTURE AND RESEARCH ABSTRACTS

The past ten years has seen an increasing array of documented research on bamboo culture in those areas of the world traditionally associated with bamboo as construction and craft medium, but also as integrated icons of poetry, diet, philosophy, religion and landscape mythology. From China to Indonesia; from India to the Philippines, new and old techniques have been married. New markets and new products have been explored, all with an eye to the knowledge that bamboo is the most diverse, useful and renewable plant material on the planet.

The following excerpts have been gleaned from current journals and notes from the proceedings of International Bamboo workshops hosted by the International Development Research Center of Canada. (See bibliography at end of paper).

Assessment of Bamboo Resources

Bamboo generally forms an understory/mixture with other tree species in the tropical natural forests. There are no pure natural bamboo stands except the dense Phyllostachys sp. (timber bamboo) in the temperate countries. Bamboos occur as a pure crop (a successional species) as a result of clear felling of natural forest of mixed species--either for regeneration purposes or in abandoned areas where shifting cultivation has been practiced in a large number of tropical countries.

David Farrelly further notes, in The Book of Bamboo, that "These bamboos (Phyllostachys sp.) include many resistant species with excellent technical properties of importance to human economy. Natural stands in China are found mixed with both deciduous and coniferous forests: after its seedling stage, the shallow rhizome does not compete with deep-rooted trees."

In the context of development of rural economies bamboo should be one of the species which should be given adequate importance in the Social Forestry/Agro-Forestry practices as well as in waste land development. There are over 160,000 hectares (one hectare=2.47 acres) of bamboo plantations in India. The area cleared for shifting cultivation in the hill regions could be reclaimed by planting bamboo at frequent intervals along the slopes and permitting cultivation in the intervening space with either agricultural, horticultural, or forestry crops. This type of agro-forestry with bamboos can be used not only to protect the hillsides from erosion but also to increase the resources (Hammer Master, 1981).

Bamboo resources should, however, be developed at village level. People in North Eastern India, Bangladesh, Thailand, Philippines and Indonesia raise large quantities of bamboos of different species in and around their homesteads for their local requirements and to serve as a wind belt. If planting of bamboos by farmers along the fringes of their farms, along water courses and homesteads is encouraged it would lead to the creation of enormous bamboo resources and raw materials in the rural sector of all the countries.

Vietnamese Homestead Schematic

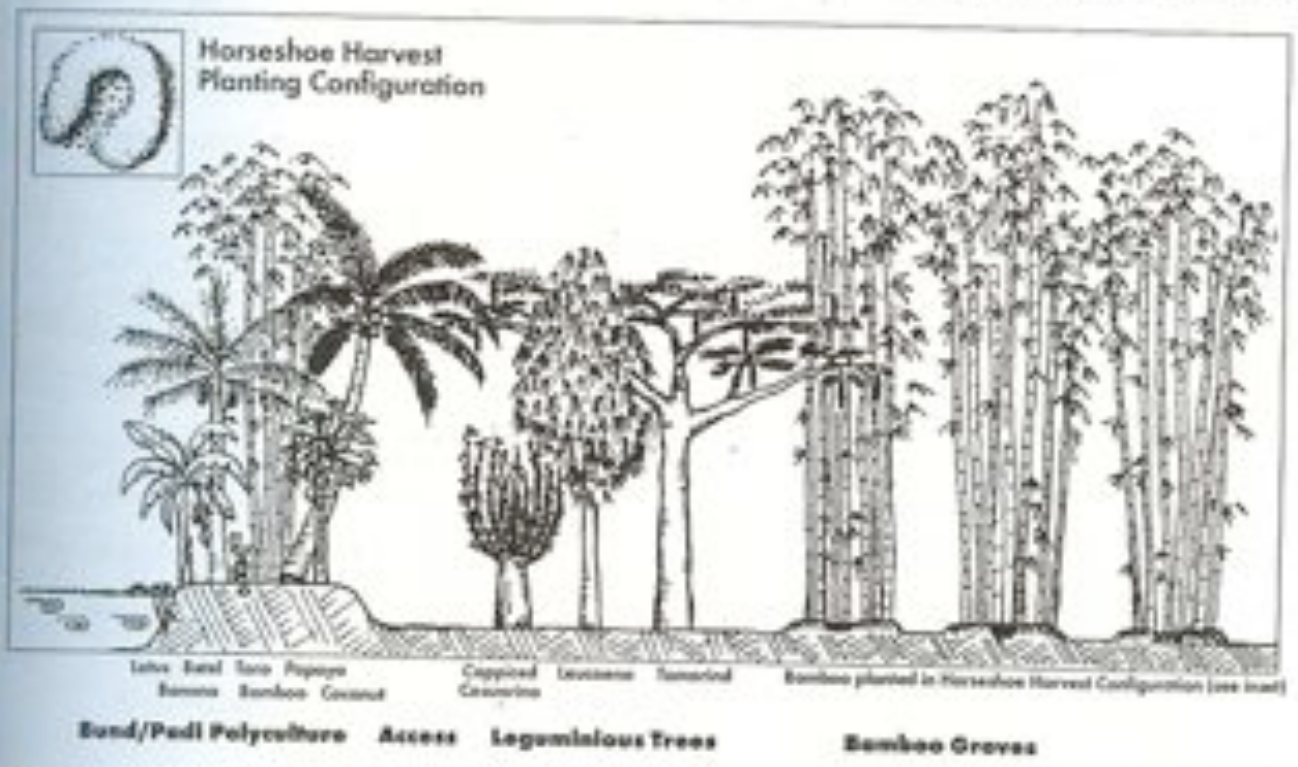
Integrated with bamboo Agro-Forestry Plantation. Modeled after traditional Vietnamese Farm Polyculture known as VAC, an acronym comprised of three disciplines: 'Vuon', the garden or orchards 'Ao', the fish pond; and 'Chuong', animal housing for pigs and poultry.

Figure A-1

Concept by Simon Henderson Art by Don Smith

Fig. A-1

CONCEPTUAL PROFILE: BAMBOO/AGRO-FORESTRY COMPLEX



Graphic by Simon Henderson

FIGURE A-2

Fig. A-2

Figure

Integrated Bamboo Production

on one thousand acres features intact natural riparian corridors, fish/fertilizer/irrigation syste, livesto forage, fruit, nut and timber trees, vegetable production, diversified bamboo culture with processing a shipping facilities and self-sufficient residential villages for employees and families.

Fig. A-4

Bamboo Resources & Bibliography

(1) Recent Research on Bamboos: Proceedings of the International Bamboo Workshop. October 6--14, 1985, Hangzhou, People's Republic of China. Proceedings published jointly by: The Chinese Academy of Forestry, People's Republic of China & International Development Research Centre, Canada

(2) Bamboos: Current Research: Proceedings of the International Bamboo Workshop. November 14-18, Cochin, India. Published jointly by: The Kerala Forest Research Institute, India and International Development Research Centre, Canada

(3) The Journal of the American Bamboo Society. 1991. Proceedings of the Second International Bamboo Conference, June 7-9, 1988. Bambouseraie de Prafrance, near Anduze, Gard, France. Sponsored by The American Bamboo Society and organized by The European Bamboo Society.

(4) Bamboo And Its Use: International Symposium on Industrial Use of Bamboo. Beijing, China, 7-11 December, 1992. International Tropical Timber Organization & Chinese Academy of Forestry

(5) The Book of Bamboo by David Farrelly, Sierra Club Books, 1984.

(6) Vietnam--the way it was. by Rosemary Morrow, Earth Garden Journal, Winter Issue, Number 88, June-August 1994, Trentham, 3458, Australia

(7) Lessons From China--The work of George Chan. by Andrew Bodlovich, Permaculture International Journal, Issue No. 51--August 1994, South Lismore, NSW 2480, Australia

(8) Integrated Farming Project. Paper by Prof George Chan, Environmental Consultant New Strategy for Rural Development in the Tropical Delta Region of Vietnam, University of Agriculture & Forestry, Thu Duc, Ho Chi Minh City, Vietnam

(9) The Integrated Water Habitat. Paper by Prof George Chan, Environmental Consultant, University of Agriculture & Forestry, Thu Duc, Ho Chi Minh City,

Vietnam

(10) Vietnam--A travel survival kit. Lonely Planet. by Robert Storey 1993

(11) Permaculture: A Designers' Manual. by Bill Mollison. Tagari Publications. Tyalgum, Australia 1988

(12) The Freshwater Aquaculture Book. by William McLarney. Hartley & Marks. Publishers. 1984

(13) A Manual of Freshwater Aquaculture. by R. Santhanam, N. Sukumaran, and P. Natarajan. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India. 1990

(14) Forest Gardening by Robert A de J Hart. Published by Green Books. 1991

(15) Selection and Management of Nitrogen-Fixing Trees. by Kenneth G. Mac Dicken. Winrock International Institute for Agricultural Development. 1994

(16) Agro-forestry in South Asia: Problems and Applied Research Perspectives. Editors. W.R. Bentley, P.K. Khosla, & K. Sekler. Winrock International Institute for Agricultural Development. 1993

PARTICIPANTS IN THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qty	att'd
Jerry Kustich/Winston Rod Co.	East Third St., Drawer T	Twin Bridge	MT	59754	406/684-5674	1	
Herbert & Patricia Hillery	1909 Richcreek Rd.	Austin	TX	78757	512/452-7146	2	x
Timothy Keenan	7229 Tegner Dr.	Rosemead	CA	91770	818/573-4753	1	
Bill Teague	1244 Umatilla	San Diego	CA	92014		1	x
George & Betty Shor	2655 Ellentoen Rd.	La Jolla	CA	92037-1147	619/453-0334	2	
David Morse	9515 Genesee Ave., Apt. 108	San Diego	CA	92121	619/622-9124	1	
Lee Mauck	P.O. Box 87	Bard	CA	92222		1	x
Doug Richardson/Seaside Banana Gardens	6823 Santa Barbara	La Conchita	CA	93001	(805) 643-4061		
Richard Haubrich	P.O. Box 640	Springville	CA	93265	209/539-2145	1	x
Kevin & Jeannie Kaiser	537 Jones St., #1433	San Francisco	CA	94102	415/457-7372	2	
Daniel Smith & Sherri Levine/Smith & Fong Co.	222 1/2 Winfield St.	San Francisco	CA	94110	415/285-8230, FAX too	2	x
Tony Valerio	918 Naples St.	San Francisco	CA	94112	415/333-8227	1	x
Bruce Bagnoli	7 Myrtle Ave.	San Rafael	CA	94901	415/456-7203	1	x
Brent O'Neill	690 Arlington Circle	Novato	CA	94947	415/883-3950	1	x
Matt Henry	600 Park Ave. 13A	Capitola	CA	95010	408/688-4048		
Karl F. & Ginger Bareis	2900 Smith Grade	Bonny Doon	CA	95060	Fax408/427-0443, tel 427-1034	2	x
Jim Ryan	1212 N. Branciforte Ave.	Santa Cruz	CA	95062	408/429-6005,Fax459-3422,	1	x
Nevin Smith & Chris Brian/Wintergreen Nursery	358 Merk Rd.	Watsonville	CA	95076	408/724-1787	2	

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qty	att'd
Niel P. Smith	3761 San Pablo Ct.	San Jose	CA	95127	408/764-0655,FAX 258-2023	1	
Hue Dang	442 Clogstan Ct	San Jose	CA	95133		1	x
Julianne Swan	C/O P.O. Box 703	Albion	CA	95410		1	
Joyce E. Hall	P.O. Box 466	Albion	CA	95410	707/937-5567	1	x
Lance Van Orsdel	32191 Albion Ridge Rd.	Albion	CA	95410-0631	707/937-4104	3	x
Mike & Maggie Van Dame	P.O. Box 214	Covelo	CA	95428	707/983-6826		
Rick Miller	10749 Woodside Dr.	Forestville	CA	95436	707/887-1257	1	x
Sharon Bear & Judy Summers	44890 Gordon Ln.	Mendocino	CA	95460	707/937-2728	2	x
Hastings & Terri Schmidt	3790 Harrison Grade	Sebastopol	CA	95472	707 874-1045, hm 874-1062	2	x
Gerald Bol	666 Wagnon Rd.	Sebastopol	CA	95472	707/823-5866, FAX 829-8106	1	x
Susan Black	2526 Pleasant Hill Rd.	Sebastopol	CA	95472		1	
Jon M. Des Pacio	1260 W. Seaton Rd.	Sebastopol	CA	95472	707/823-0590	1	x
Rich Simpson	1270 B St.	Arcata	CA	95521	707/826-9212	1	x
Shao Way Wu	1250 C st.	Arcata	CA	95521	707/822-8810	1	x
Stan & Patricia Larson	1836 Iverson	Arcata	CA	95521	707/826-7558	2	x
Mary Brooks	105 Pine St.	Crescent City	CA	95531	707/464-1053	1	x
Harold Neufeld	Box 669	Redway	CA	95560	707/923-2092	1	x
W.R. Ross	P.O. Box 250	Smith River	CA	95567	707/487-3775	1	x

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qty	att'd
Brian D. Wright	P.O. Box 1733	Diamond Springs	CA	95619		1	
Bob Champitt/Happy Horticulture	2100 Meadow Vista Rd.	Meadow Vista	CA	95722	916/878-1035	1	x
Bill V. Brown	P.O. Box 787	Fall River Mills	CA	96028		1	
Larry Reuter	P.O. Box 817	Kolsa	HI	96756	808/639-4235	1	x
David Crabtree	74 W Exchange	Astoria	OR	97103	503/325-4150	1	x
Elizabeth Boyd/Elysian Garden	26400 NW Lobo Ln.	Hillsboro	OR	97124	503/647-0100	1	x
Ned Jaquith	1507 SE Alder	Portland	OR	97214	503/231-7322	1	x
Richard Valley	P.O. Box 86291	Portland	OR	97286-0291	503/774-6353	1	x
Mike Wetter	845 McGilchirst SE	Salem	OR	97302	503/581-3493,FAX364-5846		
John Huffaker/Economic Dev. Dept	775 Summer St. NE	Salem	OR	97310	503/373-7361		
Rick V. Lennon	48121 Cascadia Dr.	Cascadia	OR	97329	503/367-6045	1	
Mike Remmick& Anne Piotto	318 SW 10th, Apt. 2	Corvallis	OR	97330	503/753-4929, wk 737-5447	2	x
Daryl Ehrensing/Dept. of Crops & Soil Science	Oregon State University	Corvallis	OR	97331	503/737-5891,FAX737-3407	1	x
Mike & Anne Remmick	318 SW 10th, Apt. 2	Corvallis	OR	97333		2	x
Brad Schmidt	766 E. Ellendale	Dallas	OR	97338	503/623-5484	1	x
Don Emenhiser	P.O. Box 946	Corvallis	OR	97339	503/754-6435	1	x
Paul Prosch/Jensen Nursery & Landscaping	P.O. Box 787	Philomath	OR	97370	503/927-6437	1	
David Faust	27160 SW Southville Rd.	Sheridan	OR	97378	503/843-2478	1	x

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qty	att'd
Bob & Mary Brendle	P.O. Box 731	Sweet Home	OR	97386	541/367-2845	2	x
Roger & Norma Chrysler	3095 Solomon Loop	Eugene	OR	97405	541/343-5286	2	x
Helen Planeto		Agness	OR	97406	541/247-7587	1	x
Gary Ekker	P.O. Box 761	Bandon	OR	97411	541/347-4103	1	x
Katy Cooper	1450 Riverside Dr.	Bandon	OR	97411	541/347-9879	1	
Tom & Susan Taylor	15524 Winrver Dr.	Brookings	OR	97415	541/469-3098	2	x
Ron Callison	99211 Blackberry Ln.	Brookings	OR	97415	541/469-6539	1	
Bill & Debbie Farrell	P.O. Box 1677	Brookings	OR	97415	541/469-1900	2	x
Jeff Smith	P.O. Box 714	Brookings	OR	97415	541/469-9616	1	x
Barny Amdahl	Rt 1, Box 1110	Coquille	OR	97423	541/396-5371	1	
Bob Nelson	P.O. Box 304	Coquille	OR	97423	541/396-2360	1	
Garold & Carole Lee Nelson	Rt. 1, Box 3925	Coquille	OR	97423	541/396-4356	2	x
Chris & Cindy Hagemaier	1162 Longview Dr.	Elkton	OR	97436		2	
David & Lisa Walter Sedlacek/Laurel Bay Gardens	85276 Glenada	Florence	OR	97439	541/ 997-2949	2	x
Ron Crook	P.O. Box 6068	Pistol River	OR	97444	541/247-7253	1	
Maurine O'Conner	P.O. Box 102	Gold Beach	OR	97444	541/247-5007	1	
Tim Scullen	P.O. Box 1518	Gold Beach	OR	97444	541/247-4909	1	x
Sharon Algozer		Gold Beach	OR	97444	541/247-6878	1	

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qtr	att'd
Irene & Lewis Orr	P.O. Box 1276	Gold Beach	OR	97444	541/247-6819	2	x
Mureen Walker	P.O. Box 6089	Pistol River	OR	97444	541/247-6850	1	x
Dan Nickell/OSU Extension Service	P.O. Box 488	Gold Beach	OR	97444	541/247-6672	1	
Henrietta DeVore	30301 Hillside Ter.	Gold Beach	OR	97444	541/247-6040	1	x
Gib & Diane Cooper	28446 Hunter Creek Loop	Gold Beach	OR	97444	541/247-0160, 247-0835	2	x
Fran Grossman	94330 Schreiber Dr.	Gold Beach	OR	97444	541/247-7561	1	
Luke Martinez (Alexandra Eyer-maybe)	26231 Myers Creek Rd.	Gold Beach	OR	97444	541/247-6459	2	
Mr. & Mrs. Henry G. Lustig	33890 Miller Lane	Gold Beach	OR	97444	541/247-4409	2	
Wade Lindsay & Jim Donaldson	P.O. Box 172	Langlois	OR	97450	541/348-2503	2	x
Darcy & Robert Hazelton	394 Pinto Dr.	Oakland	OR	97462	541/459-1585	2	x
Anita Jottrand	P.O. Box 152	Pt. Orford	OR	97465	541/332-0229	1	x
Bob Warring	P.O. Box 798	Port Orford	OR	97465	541/332-0735	1	x
Bonnie Allen & Michael McDonough	P.O. Box 275	Sixes	OR	97476		2	x
Howard Teague (moved to WA State)	P.O. Box 0132	Wedderburn	OR	97491-0132	541/247-6051	1	x
Mike McGuire	4790 Dark Hollow Rd.	Medford	OR	97501	541/773-8171	1	
Kerry Holman & Laurie Prouty	12290 Takilma Rd.	Cave Junction	OR	97523	541/592-2549	2	x
Larry Goynes	3333 Dick George Rd.	Cave Junction	OR	97523	541/592-2087	1	x
Don Hufman	P.O. Box 38	Gold Hill	OR	97525	541/855-1819	1	x

PARTICIPANTS OF THE 1994 PACIFIC NORTHWEST BAMBOO AGRO-FORESTRY WORKSHOP

Name	Address	City	State	Zip	Telephone	qty	att'd
Tim & Tammy Ogden	315 SW L	Grants Pass	OR	97526	541/479-4434	2	x
Bob & Geri Mouris	1409 Talent Ave.	Talent	OR	97540	541/535-5835	2	
Jim Engan	20014 - 135 pl. SE	Kent	WA	98042	206/684-1053	1	
Stuart Brune/Bamboo People	322 North 82nd St.	Seattle	WA	98103	206/781-1437	1	
Jake Lehrer	12810 SW 236th St.	Vashon Island	WA	98070	206/463-5509	1	
Jim Mars	15019 Vashon Hwy. SW	Vashon	WA	98070	206/567-4178	1	x
Susan Irving Yates	22231 103rd Ave. SW	Vashon Island	WA	98070		1	
Jake Lehrer	12810 SW 236th St.	Vashon	WA	98070	206/463-5509	1	x
Simon Henderson/Bamboo People	322 North 82nd St	Seattle	WA	98103	206/781-1437	1	x
Daphne Lewis/Bamboo People	322 North 82nd St	Seattle	WA	98103	206/781-1437	1	x
Ed Louie/Guangning Bamboo Manufacturer	P.O. Box 48229	Seattle	WA	98148-0229	206/242-5132, 5131,FAX244-1592	1	
Erica Harris/Woodland Park Zoo, et al	12260 1st Ave. S	Seattle	WA	98168	206/242-8848,FAX648-4854	3	x
Mike Brondi	1219 E. Sauk Rd.	Concrete	WA	98237	206/853-8449	1	x
Tim Gallagher	124 W. Go Onna	Quilcene	WA	98376	206/765-4574	1	
John & Pat Kugen	4201 Lake Aberdeen Rd.	Aberdeen	WA	98520	206/533-8341	2	x
Barry & Ellen Penswick	333 Wenas Pl.	Richland	WA	99352	509/627-4594	2	x
Art & Katherine Pulawka	RR 1	Pender Is.	BC	V0N 2M0	604/629-6101	2