VOLUME 11

In Partnership for a Better World (INBAR)

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Preface

Walter Liese
Session Chair

The Session Chair had his first contacts with bamboo in 1951. Trials were done to use its culms as pit props in German coal mines for the rare timber, but bamboo failed under pressure by sudden collapse. A closer contact began in 1957/58, with an FAO assignment for bamboo preservation in India. Since then, a greater number of consultancies were undertaken in numerous countries, beside the official functions as Professor of Wood Science at Hamburg University, with the main research beginning in 1963 on wood structure, deterioration and protection. After official retirement in 1991, the bamboo mission could be intensified with research, consultancies, and publications; for example, two INBAR-edited books.

As President of IUFRO (International Union of Forest Organizations) from 1977-1981, the moderate interest of the International Development Research Centre (IDRC) of Canada was intensified to lead to cooperation, and finally, to the creation of the International Network for Bamboo and Rattan (INBAR).

The five papers of this Session will give an overview about INBAR's mission, its achievements and further responsibilities for the wise use of bamboo.

-The potential of bamboo to contribute to sustainable development and environmental protection at the local, national and global level can only be realized if all actors work together.

-Facilitating a network for partnership and collaborations is one of the main tasks of INBAR, cooperating with other international Agencies, like FAO, ITTO, UNDP, CIFOR.

-The session will present examples of how such partnerships and collaboration facilitated by INBAR cooperate at different levels, and for different purposes.

-It is most fitting to have the Session, Partnership for a better World, at the end of this very inspiring conference just before we will wrap up and to illustrate the global potential of bamboo, there will be the declaring of the

WORLD BAMBOO DAY.

18 September.

Resilience Thinking Implications for Reconfiguring Bamboo Management and Governance

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Abstract

The preparedness and resilience of bio-productive agro-systems to face current challenges is reconfiguring 21st century visions of sustainable development. 'Complexity science', has evolved over the past century replacing the equilibrium view encompassing concepts such as 'carrying capacity'. Bamboo grows within a complex adaptive system, managed within dynamic social-ecological systems. The social-ecological system, highlights that the delineation of social and ecological systems is arbitrary. Sustainable development is increasingly perceived as a process involving aspects of evolutionary and co-evolutionary change. The ability to enhance resilience depends on the dynamics of the biophysical system and institutional organizational and governance processes that enable adaptive co-management of ecosystems. A major challenge to bamboo management and other bio-productive systems therefore is to maintain the resilience of the system in the face of change.

This study considers three different models which are cross-cutting across the 'three pillars' of sustainability: society, environment and economy, they are forest certification, Conservation Agriculture (CA) and a livelihoods approach. Experts have warned against having new blueprint approaches, but instead forming a patchwork of approaches to suit situational contexts. There are potential arenas for learning which arise from Forest Stewardship Council (FSC) Principles and Criteria (P&C) even if the primary goal of a non state market driven mechanism is not effective. FSC potentially plays a role in advocating forms of adaptive co-management. CA provides many learning opportunities for bamboo to transform management practices to sustainable resilient ecological systems. Moreover the livelihoods model provides a framework for understanding the need for diversity, not just biologically, but economically. Together the frames can go some way towards reconfiguring bamboo management and governance within resilience thinking.

Introduction

The preparedness and resilience of bio-productive agro-systems to face current challenges is reconfiguring 21st century visions of sustainable development. Sustainability has been one of the most widely used buzzwords since the late 80s (Scoones 2007a), however there have been shifting visions of the interpretation of sustainable development. The most widely popularized definition defines sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland 1987). Many contemporary scholars envision sustainability not as a fixed ideal (Cary 1998) or

outcome (Stagl 2007) but an evolutionary (Cary, 1998) or co-evolutionary process (Noorgard 2000) of social-ecological systems (Berkes and Folke 1998), involving reinterpretations of management and knowledge systems (Cary, 1998). Future sustainability therefore is part of co-evolutionary interactions within complex adaptive systems (Rammel 2007a). When facing the complexity of evolutionary systems analysis many scholars have highlighted the need for novel combinations of existing tools and methods rather than completely new methods (Giampietro 2004), through a mosaic of approaches to sustainable development (Stagl 2007; Rammal et al 2007b).

The need to reassess the bamboo management toolkit arises from the current challenges facing bamboo management in China. These are intensive harvesting, an increase in monocultures with associated biodiversity loss, excessive tillage, and chemical residues (Fu and Lou 2002; Lou et al. 2008), erosion and depletion of soil nutrients (Saxena et al. 2002; Zhou et al. 2006; Jiang 2007). This is not to say that *all* bamboo in China is unsustainably managed, however as China is the model of bamboo development (FAO 2008), this is a trend that is being followed as areas become more developed. This need is becoming more acute as the IPCC report identifies that climate is changing with ramifications for both human and non human systems (IPCC 2007). In 2008 the worst snow disaster in 100 years hit China**,** killing more than 100 people**.** The Chinese government pledged $1.2 billion to rebuild homes, farms and help those in need (Ho 2008). Large areas of bamboo forests were lost, particularly within monoculture stands, causing significant loss of livelihoods. The bamboo farmers are particularly vulnerable due to managing bamboo under high yielding regulations for high economic gains (GB 2006).

According to Diamond (2003) past societies collapsed due to a lack of environmental governance. Vulnerability therefore needs to be understood in the context of political and economic systems that operate at national and international scales (Wisner et al. 2003). The shift to considering socio-ecological systems(rather than just ecological) has triggered the emergence of analytical frameworks like socio-ecological resilience, adaptive co-management, and adaptive governance, all of which can be related to matters of institutional function (Galaz et al. 2007; Leach and Smith 2007).

This paper intends to address the implications of considering resilience in the practice and governance of bamboo management. Three current niche models will be assessed which advocate 'sustainable development,' those of Forest Stewardship Council (FSC) certification, Conservation Agriculture (CA) and the livelihoods model developed by the UK Department for International Development (DFID) in an attempt to consider holistic arenas for brokering knowledge. The paper aims to highlight the potential for adaptive and transformative systematic change.

Theory

The modernisation of bamboo management institutions is key to meeting policy challenges and realising opportunities of bamboo management. Institutions can be defined as societal rules or the human constraints that govern political, social or economic exchange (North 1990). The literature of socio-ecological systems provides a valuable framework for thinking about new or transformed institutions for bamboo management. Key concepts

within this literature are Complex Adaptive Systems (CAS), resilience thinking, as well as approaches to brokering learning, primarily transformative change.

Complexity theory, rather than an equilibrium view, underpins the socio-ecological approach (Scoones 2007b). For example under the equilibrium view bamboo management focuses on annual allowable cuts, however studies in India found that the retention of the protective covering of the axial branches was more important than annual allowable cuts (Prasad 1985). In contrast to equilibrium, the notion of a complex adaptive system (CAS) views sustainable development as a dynamic process of reciprocal feedback between the social-ecological system (Berkes and Folke 1998), with external 'social' and internal 'ecological' aspects of an integrated system (Folke 2005). A CAS approach is important for natural resource management systems in order to emphasise that structures adapt to changing external environments over temporal scales. Sustainable development is increasingly perceived as a process involving aspects of evolutionary and co-evolutionary change (Rammel et al.2007a). Sustainable development is about creating and maintaining our options for various co-evolving elements of social-ecological systems. (Folke et al. 2004; Stagl 2007)

Crucially the distinction between adaptation and resilience in socio-ecological systems thinking draws attention to the distinction between reactive policy and policy which is robust to changing circumstances. The recent snow disasters and current state of intensively managed forests in China is proof that bamboo policy has been largely reactive to changes in circumstances. A major challenge to bamboo management and other bio-productive systems is to maintain the resilience of the system in the face of change. Resilience is defined as the capacity of a system to absorb disturbance and undergo change whilst retaining fundamentally the same functions, structure, identity, and feedbacks (Folke 2006).

Leach and Smith (2007) argue that the ability to enhance resilience depends on the dynamics of the biophysical system and institutional organizational and governance processes that enable adaptive co-management of ecosystems. Central to this process will be transformative learning. Adaptability is the capacity of actors in a social-ecological system to manage resilience in the face of uncertainty. In contrast, Walker et al. (2004) define transformability as the capacity to create a fundamentally new system when ecological, economic, or social conditions allow. Transformative change can occur as a result of three key events: ecological crises, shifts in the social components of the system, such as in social values or resources (Folke et al. 2004) or economic or political change (Olsson et al. 2006). Two significant areas of learning present themselves with bamboo management to create an arena for change, through experiencing crisis and niche adoption of practice (representing potentially both social and economic change).

Crisis can act as a catalyst for learning (Westley 1995). The majority of breakthrough thinking is the result of a response to crisis (Stagl 2007). After the worst snow disaster for 100 years in China, farmers began to realize how vulnerable their bamboo stands were without the support of trees. Monoculture areas too are experiencing higher frequency of pests and diseases, therefore providing learning through 'crisis.' Resilient system preparedness is advocated rather than learning being attributed solely to natural disasters; this is where niche practices play a significant role.

Niche-based approaches explore problem framings and search for solutions (Smith 2007). Against this backdrop three niche approaches will be considered in this study, namely the Forest Stewardship Council (FSC) bamboo

certification and Conservation Agriculture (CA) for bamboo as well as the importance of considering the diverse livelihood options will be addressed within the framework of the DFID model. Strategic niche management is concerned with two processes: the quality of learning, and the quality of institutional embedding. Learning can be limited to the technical performance or extend to complementary infrastructures. If a broad network of users and outsiders utilise the framework, then the niche may contribute to the formation of a new regime (Smith 2007).

To be effective, practitioners must engage with different systems and problem framings. This practice-based perspective accommodates plurality of approaches addressing uncertainty and complexity and does not seek to define a single model (Schön and Rein 1994). Dynamic social, technological or environmental systems must be understood in relation to both their structures and their economic, institutional or ecological functions (Thompson and Stagl 2007). Bamboo management however is further complicated by the 'frame of reference' being blurred. Although managed under forestry laws, classified as a Non-Timber Forest Product (NTFP) under FSC, a tree for the Clean Development Mechanism (Widenoja 2007) and advocated as horticulture by Indian bamboo experts, the lack of consensus highlights the pressing need for plurality of approaches, to borrow from forestry, agriculture and livelihoods development. Three models will be addressed under the banner of 'the three pillars of sustainability': society, environment and economy.

Bamboo Certification: Society?

Forest certification is a non state market driven mechanism (NSMD) (Cashore et al. 2007) encompassing the three chambers of environment, society and economy akin to the three pillars of sustainability. The feasibility and need for certification has been researched (Buckingham 2007; Lou et al. 2008). Bamboo FSC certification is currently established in areas of Zhejiang however global bamboo certification programmes have faced various efficacy issues due to finance, capacity and local comprehension of schemes, a lack of market drivers, administration challenges and predominance of certification bodies being overseas (Buckingham et al. 2009). Although the FSC Principles and Criteria (P&C) have been developed for China, it remains to be seen whether a system created for sustainable forest management can be adequately translated into bamboo management.

Although there are administrational challenges associated with certification, it also provides arenas for change in operational management. Two approaches that arise from the certification assemblage include 'adaptive co-management' and the Modular Implementation and Verification (MIV) approach. Adaptive co-management refers to the multilevel and cross-organizational management of ecosystems (Olsson et al. 2004). Fundamentally co-management is not merely about resources; it is about managing relationships (Natcher et al. 2005), thereby the certification assemblage could potentially provide an arena for change within operational approaches; the P&C have guidelines for management plans, monitoring and assessment, tenure and laws, community relations and workers rights, exceeding a beyond a narrow environmental stewardship agenda.

In order to audit multifaceted dimensions across the social and environmental spheres, the MIV was developed and approved by FSC in 2005 as a stepwise, modular or phased approach to forest certification. The aim of the approach is to identify and understand the root causes of why certain modules require improvements, not just isolate gaps (Nussbaum 2003). WWF and IKEA first developed the MIV approach as a manageable toolkit separating legal, technical, environmental and social components. The five subcategories divide the FSC P&C.

What is potentially transformative about MIV in terms of policy is that it isolates strengths and areas for intervention. In sum, bamboo certification can provide opportunities within the social sphere to build the institutional framework.

Bamboo Agro-ecology: Environment?

Bamboo requires a reconfiguration of bamboo management practices which focus on environmental stewardship for resilience. The efficacy of FSC standards is currently inconclusive, however agro-ecological alternatives which have emerged as a response to the second-generation impacts of the Green Revolution emphasise pathways of change which work with natural systems (FAO 2008), different from traditional practices. One institutional agricultural practice that has been adopted by farmers for 10 000 years is tillage (FAO 2008). An agro-ecological approach that opposes this traditional practice is Conservation Agriculture (CA). CA has three basic principles defined as minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations (Hobbs 2007). Residue retention and reduced tillage are both conservation agricultural management options that may enhance soil organic carbon (SOC) stabilization. The dynamics of Soil Organic Matter (SOM) are influenced by agricultural management practices such as tillage, mulching, removal of crop residues and application of organic and mineral fertilizers (Chivenge et al. 2007). Conservation agriculture has emerged as a new paradigm to achieve goals of sustainable agricultural production.

The biggest challenge facing CA is overcoming the past mindset whereby agriculture is nearly synonymous with the practice of cultivating the soil (Abrol et al. 2006).Tillage disrupts the soil pores left by roots and microbial activity. The bare surface exposed after tillage is prone to breakdown of soil aggregates, reduced infiltration of water and increased run-off, leading to soil erosion. When the surface dries, it crusts and forms a barrier to plant emergence. The bare surface after tillage is prone to wind erosion. Figure 2 demonstrates the negative effects stemming from inappropriate tillage practices. CA increases biotic diversity in the soil as a result of the mulch and reduced soil disturbance. It also produces higher surface soil organic carbon than when soils are tilled (Hobbs 2008).

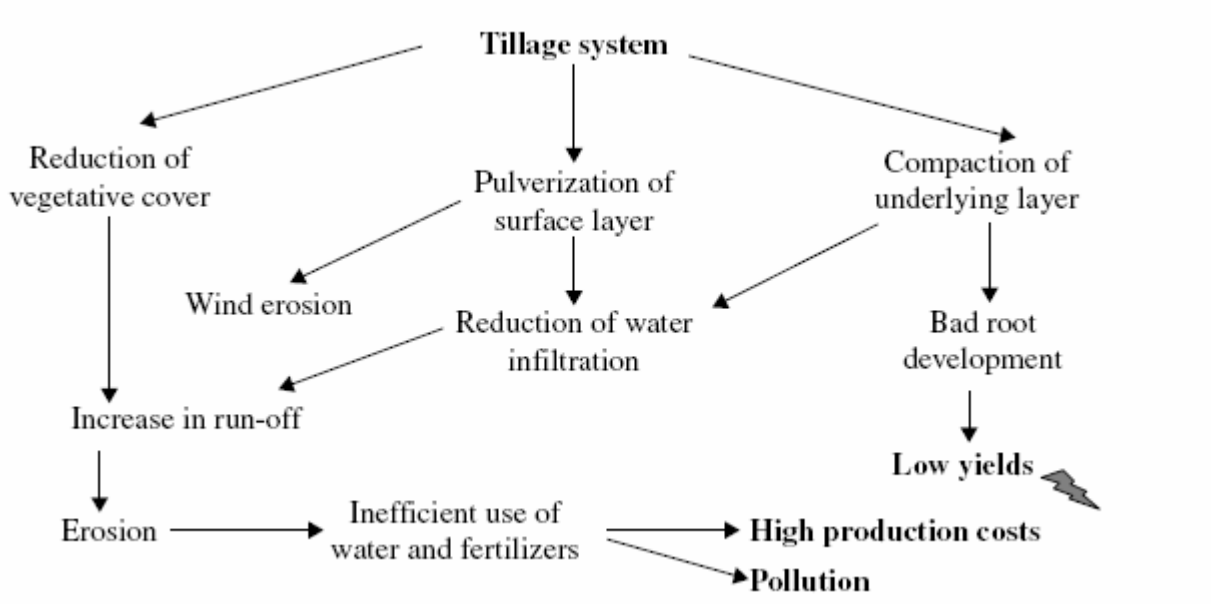

Figure 1: The effects of inappropriate tillage practices (Hobbs 2007)

CA techniques could be used for bamboo management in China. Soil degradation is one of the key problems that has arisen in recent times, particularly in the high intensively managed bamboo areas in Zhejiang. Bamboo farmers have reported digging and tilling the land and removing forest cover to create more efficient monocultures. As the first principle of CA, no till forms the corner stone of CA, however permanent soil cover and combined cropping also constitute important contributions to a robust agricultural system. Bamboo in India has already been seen to benefit from various intercropping techniques, the most famous of which is in Tripura. In 1996, bamboo was planted in India on degraded brick mining land. Within 5 years the ground water level rose from below 40 metres to 33.7 metres, the microclimate improved and 70% of the migrant labourers returned to their village communities to be involved in agro forestry (INBAR 2003).

Bamboos advantage of shallow roots, creating an opportunity for growth on marginalised lands, also presents challenges regarding the intensification of bamboo management. Deep roots are needed to enable the supply of water for transpiration. As a grass, 44% of root biomass occupies the top 10cm of soil and 75% within the top 30cm, unlike temperate and tropical trees, whereby 26% of root biomass constitutes the top 10cm and at least 78% the top 50cm (Bonan 2002); without trees bamboo lacks water for transpiration. Moso rhizomes extend to 20cm or 30cm (Jiang 2007). Moreover with the shallow root systems on often sloping land, bare land and unsustainable tillage, use of chemicals and lack of other forms of protective vegetation reduce the resilience of the ecosystem.

Bamboo as an integrated management activity in a livelihoods model: Economy?

The niche approaches discussed thus far concentrate on societal elements and environmental stewardship. Although forest certification aims to operate in niche markets as a NSMD, the efficacy to produce price premiums and economic benefits are yet to be seen, therefore the economic benefits need to be considered in robust policy instruments. Studies have found that in China bamboo is often managed as a 3 month activity (Buckingham 2008), moreover in India bamboo is managed as part of a horticultural system. Livelihood models would therefore provide useful guidelines for the matrix of approaches in order to create a holistic resilience framework for bamboo management.

Recognising and understanding the dynamics of the livelihoods process is fundamental for any analysis of resilience. Carney (1998) considers a livelihood sustainable "when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base." The structure of people's livelihoods and diversity in assets varies greatly, as do the effects of external influences upon them (Soussan et al. 2000). Figure 3 illustrates the DFID livelihood model which shows the social-ecological interconnectedness and need for diversity in approaches. This can be used as a model for learning for bamboo management through considering the internal and external forces. External forces beyond the control of farmers include the social, economic, political, legal, environmental and institutional dynamics of their local area, the wider region, their country and, increasingly, the world as a whole. Taken together, the threat of external shocks and trends directly affect the decision making environment and the outcomes of livelihoods, and provide the vulnerability context.

Rennie and Singh (1996) identify the responses of such threats as either adaptive strategies (where a household consciously adopts a process of change in response to long term trends) or coping strategies (short-term responses to immediate shocks and stresses). In these, the household will seek to deploy their different assets to best effect within their often limited range of choices. Although the livelihoods model isolates areas beyond the control of farmers themselves, it also identifies areas for policy change, since the institutional context in which the livelihood model operates is key to enhancing the resilience of the system and reducing the vulnerability within the system. Therefore when considering bamboo management, a narrow view of only enhancing bamboo management expertise should not be taken, bamboo management should be approached as one of a set of diverse livelihood options.

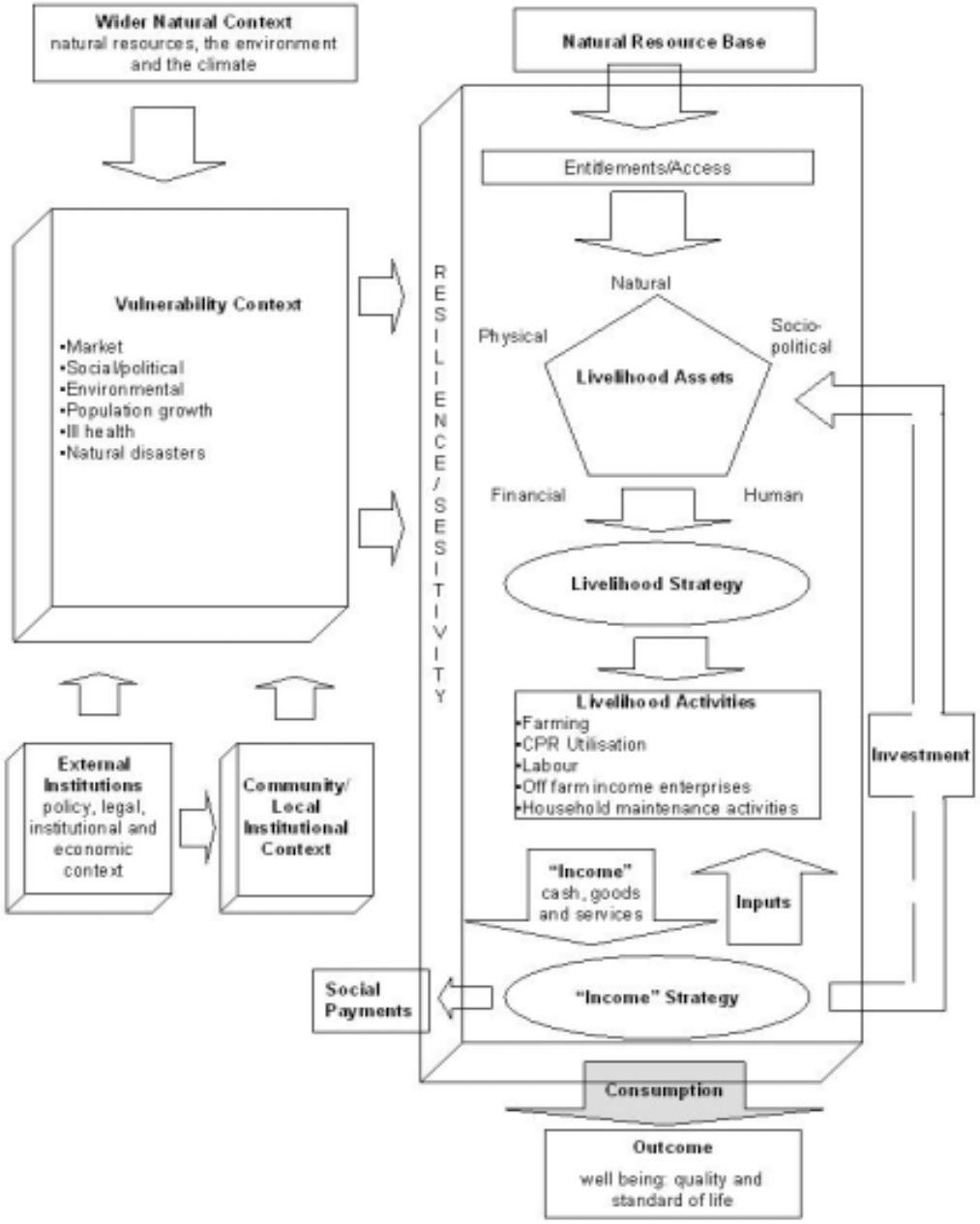

Figure 2: The livelihoods model (Soussan et al. 2000)

Conclusion

The need to reassess the bamboo management toolkit arises from the current challenges facing bamboo management in China such as intensive harvesting, an increase in monocultures with associated biodiversity loss, excessive tillage, chemical residues, erosion and depletion of soil nutrients. These challenges have been further exacerbated by the recent snow disaster in 2008 whereby bamboo farmers, particularly in monoculture stands, suffered significant losses. A major challenge to bamboo management and other bio-productive systems is to maintain the resilience of the system in the face of change. The modernisation of bamboo management institutions is key to meeting policy challenges and realising opportunities for bamboo management.

This paper has considered three policy instruments that could be applicable to assist sustainable bamboo management: forest certification, conservation agriculture and a livelihoods approach. These options present just three of the possible approaches towards an integrated approach to 'the three pillars of sustainability' through the environment, society and economy. Experts have warned against having new blueprint approaches, but instead forming a patchwork of approaches to suit situational contexts. It is acknowledged that other policy instruments such as carbon storage could also contribute to the socio-ecological dimension, however for the purpose of this paper a number of learning outcomes have been identified from the three models.

There are potential arenas for learning which arise from the Forest Stewardship Council (FSC) Principles and Criteria (P&C) even if the primary goal of a non state market driven mechanism is not effective. FSC potentially plays a role in advocating forms of adaptive co-management, moreover the Modular Implementation and Verification approach identifies strengths and gaps for enhancing policy. The second instrument, CA provides many learning opportunities for bamboo to transform management practices to sustainable resilient ecological systems. Moreover the livelihoods model provides a framework for understanding the need for diversity, not just biologically, but economically. Together the frames can go some way towards reconfiguring bamboo management and governance within resilience thinking.

The paper has highlighted the important role played by institutions to recognize the need to adapt systems to resilience with the aim to eventually move to transform systems rather than react through adaptation. Bamboo management operates within Complex Adaptive Systems (CAS) which are constantly co-evolving within social-ecological systems. Niche systems have the potential to transform to regimes if practices are widely adopted therefore such schemes act as pilots for practices. It remains to be seen whether there can ever be a perfect fit between governance and biophysical systems. Social and biophysical systems are not merely linked but interconnected. Institutions and policy prescriptions that fail to acknowledge this tight interconnection are likely to fail. (Galez et al 2008). Crucially the distinction between adaptation and resilience in socio-ecological systems thinking draws attention to the distinction between reactive policy and policy which is robust to changing circumstances. With the challenges posed by climate change there is a need for proactive rather than reactive policy.

Acknowledgements

I’d like to thank Dr Paul Jepson for his useful comments and Lewis Hussein, who drew my attention to transformative change, as well as providing useful suggestions and recommendations at the European Conference on Agriculture and Rural Development in China

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Global Bamboo Trade and the New HS Codes

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Abstract:

Due to the deterioration of global environment and pressure on the supply of timber resources, bamboo has garnered more and more attention from both producer and consumer countries throughout the world. Bamboo industry and trade contribute greatly to the global economy and trade. This study used UN Comtrade data to analysis the global trade status of bamboo products. The global trade statistics of bamboo products with different UN codes system before and since 2007 were compared and bamboo trade data in EU and China in different coding system were analyzed. The total global export and import trade value of bamboo products continuously increased in the past decades. The main bamboo products in the global market are bamboo for plaiting, mats and screens, basketwork, furniture and seats, charcoal, plywood and panels, and bamboo shoot products. Most of bamboo products were traded within and between Asia and Europe. China, EU, USA, Japan and other Asian countries with bamboo resource are the major traders of bamboo products in the world. More efforts need to be made to further add new HS Code for bamboo products and the quality of global bamboo trade data should be improved through the international cooperation on information exchange and data research.

Keywords: Global trade, Bamboo products, HS codes

As one of the most important non-timber forest resources, bamboos are found in Asia, Africa and Latin America. Bamboo products have a great potential in European and North American markets (Jiang 2002). Bamboo is a good timber substitute and processing and utilization of bamboo resources have drawn more and more attention from producer and consumer countries throughout the world due to pressure on the supply of the world's timber resources (Wu 2009). Trading in bamboo products, from raw materials to value-added products, from shoot to furniture, from charcoal to flooring, has potential to contribute greatly to the global environment, its economy and market.

HS Codes of Bamboo Products

The Harmonized Coding System (HS) is a 6-digit commodity classification system developed in the 1980s by the Customs Cooperation Council, later renamed the World Customs Organization (WCO) (Lobovikov 2003). There were 9 HS codes for bamboo, of which only 1 code was given to bamboo products specially, that is "bamboo for plaiting" and the rest 8 codes were not differentiated from the codes of wood products or other similar materials. For example, bamboo shoot products are not distinguished separately from a big variety of the

traded vegetables. Additionally, these traditional codes included only traditional bamboo items, such as bamboo for plaiting, plaited products, furniture and shoots and didn't reflect developments of industrial bamboo commodities such as bamboo flooring, panels, boards, pulp and paper, fabrics, charcoal and shoots (Wardle 2003).

With the aim of improving the quality of bamboo trade data, INBAR and the United Nations Food and Agriculture Organization (FAO) helped to develop 9 new, 6-digit codes for bamboo and 2 for bamboo and rattan furniture and seats to reflect the revolutionary changes in the bamboo industries over the preceding 10-15 years. These were formally approved by WCO in 2005, and have been effective since 2007(table 1).

Each code should collect minimum US$50 million annual trade according to HS requirements (WCO 2002). The present HS system has 12 codes for bamboo, covering 5 categories and 8 chapters, among of them 10 codes for bamboo, and 2 codes for mixed bamboo and rattan. At present, most bamboo products, both newly developed products, including pulp and paper, bamboo panels, charcoal and traditional products, such as basketwork, mats and screens, and preserved bamboo shoots, are listed in individual categories. However, the codes still need improvement. Some products (e.g. bamboo panels, bamboo shoot other than preserved bamboo shoot, handicrafts, etc.) end up listed in inappropriate product categories or not differentiated from other similar products (Jiang 2007).

Table 1 Harmonized System (HS) codes for bamboo

Codes in 2007		Codes before 2007	
Codes	Code description	Codes	Code description
# Bamboo raw materials			
140110	Bamboo for plaiting	140110	Bamboo for plaiting
		140190	Veg. materials used for plaiting(incl. bamboo)
# Bamboo plaited products			
*460121	Bamboo mats and screens	460120	Mats and screens(incl. bamboo)
*460192	Bamboo plaits and plaited prods	460110	Plaited products(incl. bamboo)
		460191	Plaits and plaited prods(incl. bamboo)
*460211	Bamboo basketwork	460210	Basketwork(incl. bamboo)
# Bamboo industrial products			
*440210	Bamboo charcoal		
*440921	Bamboo shaped products		
*441210	Bamboo plywood		
*470630	Bamboo pulp		
*482361	Bamboo paper articles		
# Furniture and seats			
*940151	Bamboo and rattan furniture	940150	Furniture (incl. bamboo)
*940381	Bamboo and rattan seats	940380	Seats(incl. bamboo)
# Bamboo shoots			
*200591	Preserved bamboo shoot	200590	Preserved vegetables(incl. shoot)

Note: * new codes effective since 2007; # headings for description purpose only in this paper.

The revision of bamboo codes reflects the rapid development of the global bamboo industry and the increasing trade of bamboo products. It also indicates that bamboo products and trade have been drawing attention both from producer countries and consumer countries.

An Overview of Global Bamboo Trade

Although the new codes for bamboo and rattan commodities have been in effect since 2007, to date the UN database for commodities hasn't yet completed data transition and adjustment. Thus the following analysis on the global bamboo trade is still based on the original four categories, nine 6-digit codes before 2007.

Commodity Composition of Global Bamboo Trade

According to UN Comtrade data (UN 2007), the global export trade value of product sectors including bamboo was US$ 6.99 billion in 2007, of which the trade value of raw materials, plaited products and furniture and seats were mixed with products made of rattan and similar materials and the export trade value of preserved bamboo shoots was mixed with other preserved vegetables. The export trade value for raw materials, plaited products, furniture and seats and peserved vegetables and shoots were respectively US$ 0.13 billion, US$ 1.96 billion, US$ 2.62 billion, and 2.29 billion, 2%, 28%, 37% and 33% respectively of the total (Table 2).

Growth of Global Trade of Product Sectors including Bamboo in 1995-2007

The total export trade value of product sectors including bamboo increased to US$ 6.99 billion in 2007 from US$ 3.89 billion in 1995, with an average annual growth rate of 6%. Products exports grew substantially, of which furniture increased fastest, up from US$ 0.90 billion to US$ 2.24 billion between 1995 and 2007 with an annual average of growth rate of 11%, followed by preserved vegetables, mats and screens with the growth rate of 8% (Figure 1).

Table 2 Global trade of product sectors including bamboo in 2007

Unit: million USD

		Import		Export	
		Value	Proportion	Value	Proportion
140110	Bamboo for plaiting	134	0.02	53	0.01
140190	Veg. materials used for plaiting	93	0.01	74	0.01
Sub-total of raw materials		227	0.03	127	0.02
460110	Plaited products	0	--	0	--
460121	Mats and screens	362	0.05	465	0.07
460211	Basketwork	1887	0.25	1424	0.20
460191	Plaits and plaited prods	64	0.01	70	0.01
Sub-total of plaited products		2313	0.31	1960	0.28
940150	Furniture	2069	0.28	2240	0.32
940380	Seats	618	0.08	378	0.05
Sub-total of furniture and seats		2687	0.36	2618	0.37
200590	Preserved vegetables	2283	0.30	2288	0.33
Sub-total of shoots		2283	0.30	2288	0.33
Grand total		7510	1.00	6992	1.00

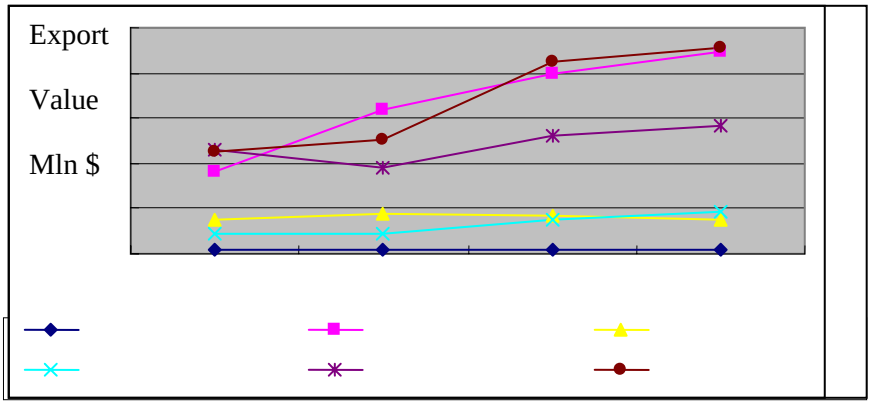

Figure 1 Global trade of product sectors including bamboo in 1995-2007

Trade Flow of Product Sectors including Bamboo Trade in 2007

According to UN Comtrade data, China, Indonesia, EU, the Philippines and USA were the top five exporters of product sectors including bamboo with market shares of 38%, 10%, 9%, 2% and 2% respectively in 2007 (figure

2). EU, USA, Japan, Canada and Singapore were the top five importers, responsible for over 59% of the total imports value of bamboo products, including raw materials, plaited products, furniture and seats.

According the data analysis, China was the largest exporter of raw materials with a value of US$ 37 million in 2007, nearly 30% of the total export value. EU was the largest importers of raw materials with a value of US$ 68 million, 30% of the total import value of materials. China, Indonesia, the Philippines, Hong Kong and USA were the top 5 exporters of plaited products including basketwork, mats and screens and EU, USA, Japan, Canada and Korea were the top 5 importers. China, EU, USA, Thailand and Malaysia were the top five exporters of furniture and seats, USA, EU, Canada, Japan and Singapore were the top five importers of furniture and seats.

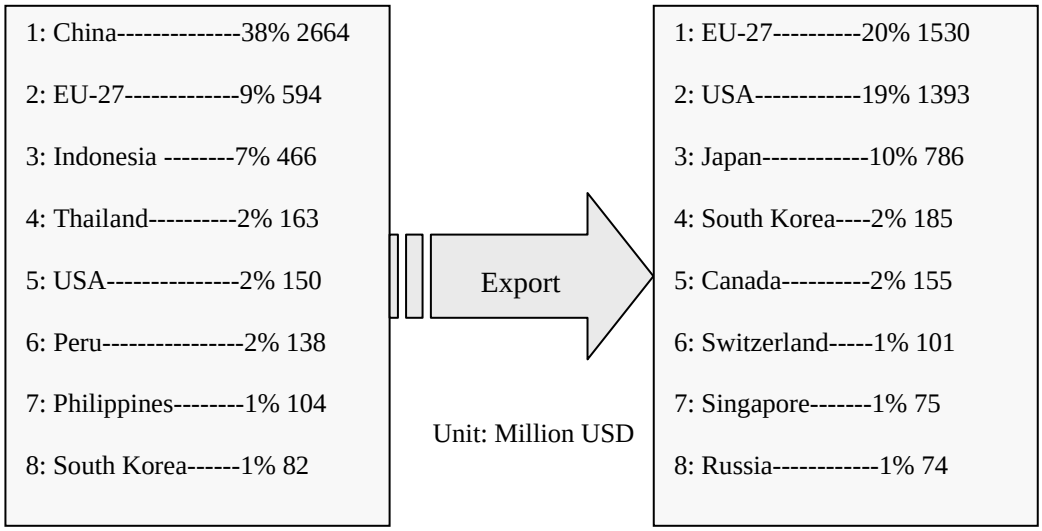

Figure 2 Top traders of bamboo products in 2007 with codes before 2007

Global Trade with New Codes

In cooperation with the International Tropical Timber Organization (ITTO) and European Forest Institute (EFI), the International Network for Bamboo and Rattan developed the Bamboo and Rattan Trade Database from 2003, based on UN Comtrade data, utilizing the Harmonized Commodity Description and Coding System (HS) used by World Customs Organization (WCO) (INBAR 2007).

Trade Statistics for Global Bamboo Trade

Bamboo trade data, partly using the new codes, was updated in the global bamboo and rattan trade database (INBAR 2007). The total export value using the new codes in 2007 was US$ 2.15 billion, which was a lot less than the data according to the code system before 2007 and obviously indicated that the updating has not been completed, and that the new codes are more accurate for some specific codes and products, such as preserved

bamboo shoots. The export trade value for bamboo raw materials, bamboo plaited products, bamboo industrial products, furniture and seats, and bamboo shoots were US$ 0.06 billion, US$ 0.55 billion, US$ 0.67 billion, US$ 0.65 billion and US$ 0.23 billion respectively, representing proportions of 3%, 25%, 31%, 30% and 11% of the total (Table 3).

The data with new codes in 2007 reflected a more accurate and proper composition and proportion of main bamboo products in global market, although the current bamboo products trade statistics still misestimate global bamboo trade as furniture and seats share codes with rattan and some bamboo products are not classified from wood and similar materials. In addition, a considerable proportion of national bamboo trade data is not stated, as many countries have not started using the new codes or have not completed transfer and updating according to the new codes.

Meanwhile, data statistics in regional or national level are usually more accurate and reliable, and are updated very timely. Analysis on the trade data of EU, the largest importer and China, the largest exporter bamboo products in the world, will be made in the following paragraphs in order to clarify the trade situation of bamboo products, using different trade data sources, including UN Comtrade data, EU trade statistics and trade data of China's Customs.

Trade Statistics for Bamboo Products in EU

As the largest importer and the third largest exporter of bamboo products in the world, EU used and developed its commodity codes within the framework of UN coding system and updated timely. There are 13 codes for bamboo products in EU coding system, of which one extra code was given to bamboo shoot other than preserved bamboo shoots (EU 2008). According to EU trade statistics, the total trade value of bamboo products in EU decreased from 2007 to 2008, of which the export value decreased from US$ 108 million to US$ 79 million and the import value decreased from US$ 612 million to US$ 466 million. N.B. It should be noted that these figures are for import and export into and from the EU as a single unit, and do not include the import and export between EU countries As the largest importer of bamboo products, the total import value in 2008 was US$ 466 million, of which 9% was for bamboo raw materials (US$ 44 million), 6% for bamboo shoot (US$ 26 million), 11% for bamboo industrial products (US$ 51 million), 27% for bamboo plaited products (US$ 129 million), 22% for furniture (US$ 105 million) and 24% for seats (US$ 111 million). As a significant exporter, the total export value of bamboo products from EU in 2008 was US$ 79 million, of which 55% were furniture and seats, 24% for bamboo industrial products, 11% for bamboo shoots, 7% for bamboo plaited products and 3% for bamboo for plaiting.

Table 3 Global export trade value of bamboo products in 2007

Unit: Million USD

Codes	Bamboo products	Data with old codes	Data with new codes	Data difference
140110	Bamboo for plaiting	53	55	2
Sub-total of bamboo raw materials		127	55	-72
460211	Basketwork	1424	289	-1135
460121	Mats and screens	465	230	-235
460192	Plaits and plaited prods	70	28	-42
Sub-total of bamboo plaited products		1960	547	-1413
440210	Bamboo charcoal	--	58	58
440921	Bamboo shaped products	--	298	298
441210	Bamboo plywood	--	248	248
470630	Bamboo pulp	--	62	62
482361	Bamboo paper articles	--	3	3
Sub-total of bamboo industrial products		--	669	669
940151	Furniture	2240	333	-1907
940381	Seats	378	320	-58
Sub-total of furniture and seats		2618	653	-1965
200591	Preserved bamboo shoots	2288	227	-2061
Grand Total		6992	2151	-4841

A comparison of trade value of bamboo products based on UN Comtrade data and EU trade statistics in 2008 was made to address the data differences by different data sources (table 4). As shown in table 4, there was a data difference between UN Comtrade data and EU trade statistics, of which UN Comtrade data overestimated US$ 28 million of the export value of EU in 2008 and US$ 5 million of the import value in 2008.

Trade Statistics for Bamboo Products in China

As the largest exporter of bamboo products in the world, China developed it national 8-digit codes within the framework of UN coding systems. Up to 2007, 26 codes had been set for bamboo products in China, of which 5 individual codes are given to bamboo shoot products, 8 codes to various bamboo panels, 6 to other industrial bamboo products, including bamboo charcoal, chopsticks, sticks, pulp and paper, 4 to bamboo plaited products, and 2 to furniture and seats (mixed with rattan) and 1 to bamboo raw materials (China's Custom 2008).

The total export value of bamboo products from China in 2008 was US$ 1.36 billion, of which 14%(US$ 193 million) was for bamboo shoots, 44%(US$ 594 million) for bamboo plaited products, 3%(US$ 35 million) for furniture and seats, 24%(US$ 324 million) for bamboo flooring, 4% (US$ 56 million) for other panels, 8%(US$ 105 million) for chopsticks and sticks, 2%(US$ 33 million) for bamboo for plaiting and the rest 1% included bamboo charcoal, pulp and paper articles(Zhang 2009). The total import value of bamboo products in China in 2008 is about US$ 16 million, of which 50% was for pulp and paper articles, 21% for raw materials, 7% for furniture and seats.

Table 4 Trade value and composition of bamboo products in EU in 2008

Unit: Million USD

Code	Products	Import		Export	
		UN data	EU data	UN data	EU data
140110	Bamboo for plaiting	46.4	43.76	2.46	2.32
Sub-total of bamboo raw materials		46.4	43.76	2.46	2.32
460211	Basketwork	38.69	36.49	1.85	1.75
460121	Mats and screens	15.39	14.52	0.97	0.92
460192	Plaits and plaited prods	82.19	77.52	2.8	2.65
Sub-total of bamboo plaited products		136.27	128.53	5.62	5.32
440210	Bamboo charcoal	8.45	7.97	1.45	1.37
440921	Bamboo shaped panels	38.61	36.42	6.86	6.47
441210	Bamboo plywood	3.05	2.87	8.85	8.35
470630	Bamboo pulp	0.23	0.22	0.12	0.11
482361	Bamboo paper articles	4.16	3.92	2.86	2.69
Sub-total of bamboo industrial products		54.5	51.4	20.14	18.99
940151	Furniture	118.1	111.4	5.44	5.13
940381	Seats	111.15	104.84	40.52	38.22
Sub-total of furniture and seats		229.25	216.24	45.96	43.35
200591	Preserved bamboo shoots	27.59	26.03	9.61	9.06
Grand Total		494.01	465.96	83.81	79.04

Although the new codes were developed for more bamboo products, the current UN Comtrade data still overestimates and misestimates the actual trade situation. A comparison of trade statistics in China in 2008 based on the data of UN Comtrade coding system and Chinese national codes showed the trade data differences with new codes for bamboo (table 5). Data difference of the total export value of China in 2008 between UN Comtrade data and Chinese national data was about US$ 316 million, which mainly came from bamboo shoot products other than preserved bamboo shoots, bamboo plaits and plaited products, bamboo chopsticks, sticks and sculpture. Obviously, it showed that some very important bamboo products with a big trade market have not been classified in appropriate categories in UN Comtrade data and further adjustment should be done for the 6-digit HS codes of bamboo products.

Conclusions and Recommendations

Importance of Global Bamboo Trade

As the most important non-timber forest product resource, bamboo is closely bound up with the life and existence of 1.5 billion people around the world, benefiting not only the producer countries but also the consumers in many developed countries. Global bamboo trade over recent decades has increased continuously, both in terms of the total value of exports and imports and the number of exporters and importers of bamboo products. The main bamboo products in the global market are raw materials, traditional plaited products, further-processed products, furniture and bamboo shoots. Asian countries with abundant bamboo resource and traditional bamboo industry are the major exporters of bamboo products in global market, especially China, which dominates the exporting market with a very significant market share. EU and USA contribute to the exporting market greatly as well, with their advanced processing technology. EU, USA and Japan are the top importers of bamboo products, either raw materials, or traditional products and value-added products.

Necessity of Additional New HS Codes for Bamboo Products

UN Comtrade data has almost separated the main bamboo commodities from rattan and many wooden products and more accurately captured key bamboo trade flows since 2007, and would be

Table 5 Export trade value of bamboo products in China in 2008

Unit: million USD

Code	Products	UN data	China's data	Data difference
14011000	Bamboo for plaiting	33.59	33.14	0.45
Sub-total of bamboo raw materials		33.59	33.14	0.45
44021000	Bamboo charcoal	7.24	5.26	1.98
44092110	Bamboo flooring	-	324.33	-324.33
44092190	Bamboo shaped products	329.34	5.03	324.31
44121011~1099	Bamboo plywood	72.2	51.32	20.88
44190032	Bamboo chopsticks	--	75.50	-75.5
44219022	Bamboo sticks	--	29.92	-29.92
44201010	Bamboo sculpture	--	11.03	-11.03
47063000	Bamboo pulp	3.29	3.72	-0.43
48236100	Bamboo paper articles	0.01	0.04	-0.03
Sub-total of bamboo industrial products		412.08	506.16	-94.08

46012100	**Bamboo mats and screens**	**195.06**	**330.56**	**-135.50**
46021100	**Bamboo basketwork**	**189.50**	**222.49**	**-32.99**
46019210/9290	**Plaits and plaited products**	**13.85**	**41.04**	**-27.19**
Sub-total of bamboo plaited products		**398.41**	**594.09**	**-195.68**
94015100	**Bamboo and rattan seats**	**17.79**	**13.79**	**4**
94038100	**Bamboo and rattan furniture**	**22.43**	**20.99**	**1.44**
Sub-total of furniture and seats		**40.22**	**34.79**	**5.43**
07099010	**Fresh bamboo shoots**	**-**	**5.17**	**-5.17**
07119031	**Salted bamboo shoots**	**-**	**11.23**	**-11.23**
07129010	**Dried bamboo shoots**	**-**	**13.51**	**-13.51**
20059110	**Preserved bamboo shoots**	**161.54**	**145.74**	**15.80**
20099190	**Other preserved bamboo shoots**	**-**	**17.72**	**-17.72**
Sub-total of bamboo shoots		**161.54**	**193.37**	**-31.83**
Grand Total		**1045.84**	**1361.56**	**-315.72**

the best available source of information to monitor the commodity composition, dynamics and prices of global bamboo trade. However it is still insufficient and needs to be further improved. For example, bamboo furniture and seats still share codes with rattan, and many important products are still classified in other categories without specific codes, such as bamboo chopsticks, craftwork as well as some new products including bamboo fiber and chemical products. Therefore, efforts to add new HS codes for bamboo products should be made and promoted with the cooperation of WCO, INBAR and relevant countries.

International Cooperation on Trade Codes and Data Quality of Bamboo

The production and consumption of bamboo products major is concentrated in Asia and Europe. The related trading countries have better developed commodity codes for bamboo products. For example, the 8-digit codes in China increased from 12 to 25 in 1992-2007 with which more and more bamboo products classified from wood, vegetables and similar materials in China's Customs codes. As one of the key importers of bamboo products, and especially as the largest importer of bamboo shoots, Japan has well developed bamboo HS codes (Wardle 2003) with individual codes for bamboo shoots, chopsticks, charcoal, etc. To improve the quality of present trade data of bamboo products, international cooperation on code and data research should be further enhanced in line with national trade status. A new HS codes proposal in future to WCO could be drafted based on a survey of national HS codes, especially with comments and experiences from the top traders. But countries need to exchange information on national bamboo trade statistics in order to improve their own bamboo HS codes and research trade on bamboo products simultaneously.

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Bamboo Biomass Energy –A Partnership between Ghana, Ethiopia, China and INBAR

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Abstract

The African continent increasingly depends on firewood and charcoal for cooking and heating homes. In 2000, nearly 470 million tonnes of wood were consumed in homes in sub-Saharan Africa in the form of firewood and charcoal, more wood per capita than in any other region in the world. Moreover, more than 1.6 million people, primarily women and children, die prematurely each year worldwide (400,000 in sub-Saharan Africa) from respiratory diseases caused by the pollution from such fires.

Ethiopia and Ghana are two African countries where the majority of households rely on wood-based fuels as the primary energy source for domestic cooking and other productive activities. Ethiopia's energy sector depends heavily on traditional firewood and wood charcoal, which account for more than 90% of final energy consumption. Similarly in Ghana, firewood and wood charcoal account for more than 78% of all primary energy consumption. These levels of consumption are highly unsustainable, with use of firewood and wood charcoal emerging as a main contributor to deforestation and air pollution.

Bamboo-based firewood and charcoal are suitable alternatives for wood-based firewood and charcoal. Because bamboo has advantages like self regeneration, sustainability of supply, environment friendliness etc; and bamboo charcoal has high heating value, which is suitable for household energy source.

This paper outlines an EC-funded project: Bamboo as a sustainable biomass energy. In this project INBAR will work in partnership with FEMSEDA and EREDPC in Ethiopia, with FORIG and BARADEP in Ghana and with Nanjing Univeristy in China and introduce and develop bamboo biomass energy technology, especially bamboo charcoal technology, for Ethiopia and Ghana.

The project action has strong potential for further replication in sub-Saharan Africa, Asia and Latin America countries, which are dependent on wood-based fuels for cooking and heating homes.

Keywords: Bamboo Charcoal, Bamboo Firewood, Biomass energy, Partnership

Introduction

In industrialised countries, wood-based fuels have long been replaced by more efficient and convenient sources of fuel. However, in developing regions, less able to afford and access alternative sources of energy, wood has remained a dominant fuel. The African continent increasingly depends on firewood and charcoal for cooking and heating homes. In 2000, nearly 470 million tonnes of wood were consumed in homes in sub-Saharan Africa in the form of firewood and charcoal, more wood per capita than in any other region in the world.[1] Moreover, more than 1.6 million people, primarily women and children, die prematurely each year worldwide (400,000 in sub-Saharan Africa) from respiratory diseases caused by the pollution from such fires.

Ethiopia and Ghana are two African countries where the majority of households rely on wood-based fuels as the primary energy source for domestic cooking and other productive activities.[2] Ethiopia's energy sector depends heavily on traditional firewood and wood charcoal, which account for more than 90% of final energy consumption. Similarly in Ghana, firewood and wood charcoal account for more than 78% of all primary energy consumption.[3] These levels of consumption are highly unsustainable, with use of firewood and wood charcoal emerging as a main contributor to deforestation and air pollution.

In Ethiopian and Ghanaian rural areas, firewood is the preferred form of domestic energy, largely because it does not require complex and expensive equipment. In addition, it can be procured often at no greater cost than collecting and preparing it. However, burning of firewood is inefficient and results in the emission of pollutants, such as carbon monoxide, methane, nitrogen oxides, benzene formaldehyde, aromatics and respirable particulate matter. Wood charcoal production is a profitable source of income for many urban and rural communities in Ethiopia and Ghana. Ethiopia produces approximately 3.2 million tonnes of wood charcoal per year, while Ghana produces 1.4 million tonnes of wood charcoal. The majority of this charcoal is produced at the household level or by micro and small enterprises (MSEs). While wood charcoal produces fewer emissions than firewood, production techniques are often highly polluting and lead to major deforestation. Deficiencies in current charcoal technologies and production skills result in poor quality products, high carbon emissions, leakages and high resource wastage.

Ethiopia's forest cover decreased from 4.2% in 2000 to 3.5% in 2005, with an annual rate of depletion of 141,000 hectares, and this trend is continuing. If this trend persists at its current rate, the forest area in the country will be reduced to less than 7 million hectares (ha) by 2020. In 2005, annual withdrawal of wood from forests was 111 million cubic metres.[4] Ghana's total forest cover decreased from 37% in 1993 to 24% in 2005 (5,517,000 ha), with an annual rate of deforestation of 115,000 hectares, and this trend is persisting. About 90% of Ghanaian wood-based fuels are obtained directly from natural forests and the savannah woodlands. From 2000-2004, annual withdrawal of wood from forests was 25-28 million cubic metres.

Constraints on the supply of electricity, which is only accessible to a very limited number of urban households, coupled with the high cost of commercial fuels, further increases the demand for biomass fuels. Today, firewood and charcoal production in both countries is responsible for deforestation, emissions and indoor air pollution. The demand for wood as biomass for firewood and charcoal making in both countries represents a serious environmental threat, which is expected to remain unchanged for many decades to come. This relentless demand is influenced by low household incomes, urbanization, and the growth of informal sector activities. Due to

increasing scarcity of wood resources and cumbersome policy regulations, demand for firewood and charcoal will vastly outstrip supply in many parts of Ethiopia and Ghana.

The International Energy Agency (IEA) predicts that by 2030 biomass energy in Africa will still account for an estimated three quarters of total residential energy. If correct, these estimates underline the urgency of facilitating a sustainable alternative biomass to replace wood biomass. The need for alternative energy sources, which are both sustainable and widely accessible to the urban and rural poor, requires urgent action. In China, India, Vietnam and Thailand, bamboo has been shown to serve as a viable and more sustainable alternative biomass fuel. Due to its extremely fast growing properties, woody nature, high-tensile strength, and carbon sequestration rates, bamboo is an ideal sustainable alternative biomass fuel. Bamboo can be selectively harvested annually for 2-4 year old culms, whereas timber forests require on average four to six decades to regenerate, with the exception of eucalyptus and prosopsis. Bamboo is comprised of cellulose, hemicellulose, lignin, potassium, silicon, phosphate[5] and extractive materials such as, carbohydrates, fat, protein, nitride etc. In addition to these components, there are some metallic elements with little content such as copper, iron, calcium, magnesium, and manganese. The cellulose content of bamboo is similar to any softwood. The resource's lignin content falls between that of a softwood and hardwood, and is higher than grass. The ash content of bamboo is 3 to 4 times more than wood.[6]

Bamboo-based firewood is cleaner and produces less pollution than wood firewood. Bamboo culms are more porous compared to timber. This leads to less wastage as the entire bamboo resource can be burned, resulting in less pollution. Bamboo charcoal produces fewer emissions than wood-based fuels and prevents deforestation. The surface area pores of bamboo charcoal are up to 500 m2 per gram compared to wood charcoal with only 100 m2 per gram. Bamboo charcoal has excellent properties for water purification, three times more than wood charcoal. Bamboo charcoal has a calorific value of 26-29 MJ/kg, equivalent to wood charcoal. Bamboo charcoal briquettes enhance the energy output of charcoal, as they burn through gasification from the inside outwards. Normal wood charcoal burns through direct combustion, which is inefficient, because it burns from the outside inwards. In addition to energy loss, direct combustion also produces larger amounts of waste gases, which are toxic and cause respiratory diseases.

Therefore, the project described in this paper aims to promote the production and consumption of bamboo firewood and charcoal, which, due to its cleaner processing technology, drier nature, and sustainable resource base is thought to be an attractive and sustainable alternative for wood based biomass derived energy sources.

The project's overall objective is to increase the use of bamboo as a source of energy for the poor of Ethiopia and Ghana thereby providing a more sustainable, environmentally friendly and economical alternative to firewood and wood charcoal.

The specific objectives are:

(1) to develop over a four year period the bamboo resource base in Ethiopia and Ghana so that the appropriate varieties are available for long-term firewood and charcoal use;

(2) to develop over a four year period a small-scale private bamboo firewood and charcoal sector to ensure appropriate supply for target populations;

(3) to put into place the institutional support needed for bamboo to be widely adopted as each country's primary source of energy for the poor, through development of appropriate policies, capacity building and awareness raising.

INBAR's partnership with Ethiopia, Ghana and China for the project implementation

Ethiopia and Ghana:

Ethiopia's bamboo resources amount to 1 million ha and constitute 7.7% of the country's total forest cover.[7] Ghana has approximately 300,000 ha of bamboo resources, which cover 5% of the country's total forestland. The availability of bamboo resources in both countries makes bamboo a viable biomass alternative for energy. Bamboo is one of the fastest growing plants on earth, which makes it a quickly-renewing and sustainable source of biomass for the poor. Bamboo charcoal's heating value is over 30,000 joules per gram, offering comparable heating properties to wood charcoal for cooking and heating.[8] In Ethiopia, the average annual dry bamboo culm increment is 10 tons/ha and thus it is possible to harvest over 10 million tons annually of dry bamboo for biomass energy. With a 30% bamboo charcoal yielding rate, sustainable harvest of bamboo resources could potentially provide 3.3 million tons of bamboo charcoal annually; it is possible, therefore, that bamboo charcoal could potentially replace all wood charcoal production. Ghana has a strong potential to produce 0.9 million tons of bamboo charcoal on a sustainable basis with a 30% yielding rate, so bamboo could potentially replace 64% of the country's wood consumption for charcoal production.

China:

China is one of the countries with richest bamboo resource and has over 500 bamboo species and 4.86 mil ha bamboo forest. Its annual output is over 7 billion EUR in bamboo sector. China has a long history on bamboo cultivation and sustainable management of bamboo forest and bamboo has been widely used in environmental protection, livelihood, economical and social development. As an alternative of wood charcoal, bamboo charcoal has been produced in China and its annual production is over 100,000 tonnes. The experiences on bamboo biomass production and bamboo charcoal production as well relevant energy saving stove technology and bamboo charcoal briquette technology are shared with the partners in Ethiopia and Ghana through study tours, training, technology transfer, publications etc.

INBAR's global experience:

INBAR and its partners in Asia have demonstrated that bamboo charcoal is a viable alternative to wood for fuel and charcoal used for cooking and heating. Such projects have proven that through capacity building and training activities, wood charcoal producers can easily shift to produce bamboo charcoal. INBAR partners in China and India, where bamboo plantation management and charcoal making technologies are the most advanced in the world, are actively involved in the organisation's charcoal projects in Asia and Africa. Bamboo

charcoal is produced through controlled burning of bamboo in improved traditional charcoal making kilns, low technology metal kilns and brick kilns. Since 2002, *INBAR* has developed and field-tested technologies that make it possible to produce large quantities of bamboo charcoal at the community level. These activities stimulate local production, enabling households to access and consume affordably priced, sustainable bamboo firewood and charcoal. Drum kiln technology has also been developed to produce bamboo charcoal briquettes, commonly used for heating and cooking, and capable of burning for approximately 2.5 hours. This results in low emissions of greenhouse gases. Wastage can also been reduced, as the surplus material from other bamboo based projects is used to produce charcoal.

For many years, INBAR has been working closely with local government institutions to promote bamboo for livelihood and economic development and environmental sustainability in both Ethiopia and Ghana. For instance, in 2003, INBAR began working with the Ghanaian government and local partners to develop a National Bamboo Strategy. Since 2005, INBAR has supervised a Common Fund for Commodities (CFC) project for East Africa, which encompasses the development of an Ethiopian National Bamboo Strategy in collaboration with Ethiopian government agencies. The long-term objective of the project is to promote the development of sustainable production and use of bamboo products in East African countries, with a focus on markets as the driving force behind such sectoral development. In both 2005 and 2006 INBAR has organized a 2-month training workshop on bamboo cultivation and utilization in Ethiopia, with support from the Chinese government. From 2007 to 2009, the Global Non-Timber Forests Products Partnership Programme (NFTP-GPP), coordinated by INBAR, has been implementing an International Fund for Agricultural Development (IFAD)-funded project “Assessing and Developing Replicable Methodologies and Approaches for Sustainable Charcoal Production for Livelihood Development, Rural Energy Security & Environmental Protection”. The project is focussed on sub-saharan Africa and aims to help develop charcoal production into a sustainable option for addressing rural poverty and rural energy security, while contributing to environmental protection.

INBAR is the project’s main implementing agency. The project is executed with four main local implementing partners, EREDPC and FeMSEDA in Ethiopia and BARADEP and FORIG in Ghana.

The project will also draw on the expertise of universities, research institutions, NGOs, and the private sector in the implementation of capacity development and awareness creation components.

INBAR and local project partners will establish five pilot demonstration sites showcasing effective, adaptable models for bamboo firewood and charcoal production. The demonstration sites are the way in which the Action will promote replication of appropriate technologies, with models to illustrate different aspects of bamboo for firewood use and charcoal production. Activities at the demonstration sites will focus on sustainable management of the resource base, and optimal resource management. International and national policy consultants and trainers will implement certain project components in their respective areas of expertise. These include bamboo charcoal briquette production and use, bamboo best cultivation practices and marketing strategies.

The project seeks to overcome the challenges identified below, which, if not addressed, will result in an unsustainable reliance on wood-based fuels.

1. Current unsustainable use of wood as biomass for firewood and charcoal making
2. Major negative environmental consequences of increased wood charcoal production (deforestation, reduction of carbon sequestration, loss of biodiversity and desertification)
3. Inefficient and wasteful wood-based fuels production
4. Poor marketing and inadequate regulation of the wood-based fuels energy industry
5. Prohibitive policies and regulatory mechanisms that support inefficient wood-based fuel activities
6. Lack of technologies and incentives to develop sustainable energy from biomass

The project will address these challenges through: a) improving the production of fuel from existing bamboo resources, through better sustainable management techniques and plans and an increased use of bamboo charcoal where appropriate, b) establishing pilot sites to demonstrate best bamboo as firewood practices, innovative construction and operation technologies for bamboo charcoal production, and bamboo firewood and charcoal energy saving stove technology, thereby successfully transferring and introducing bamboo technologies to meet local energy needs, c) creating the right climate for profitable and sustainable bamboo firewood and charcoal production and use, through enacting sound policy recommendations and a national marketing strategy, d) hosting workshops with key stakeholders and establishing village level bamboo charcoal MSE associations, which will create dialogue between government, industry, MSEs and civil organisations, e) implementing training and demonstration events for policymakers, local energy development personnel, local households, and MSEs, which will build the capacity of target groups and beneficiaries to replace wood with bamboo for firewood and charcoal production, f) publishing best practices and technologies, which will lead to increased awareness of the benefits of bamboo firewood and charcoal.

Expected results

This 4 year project expects to achieve the following results:

- **Result 1: A sustainable local resource base for bamboo will be in place in both Ethiopia and Ghana, sufficient to supply households and small enterprises to substitute bamboo for firewood and charcoal.** Local infrastructure to ensure a sustainable local resource base for bamboo firewood and charcoal production in Ethiopia and Ghana needs to be established. The project will ensure local infrastructures exist to promote a sustainable local resource base for bamboo through the development of inventory analyses for bamboo resources in Ethiopia and Ghana and the introduction and propagation of five bamboo species suitable for firewood and charcoal in both countries. Indicators for achieving this result include two inventory analysis reports, successful introduction, propagation and cultivation of five bamboo species at the Action's bamboo nurseries, and their seedlings planted in the Action's pilot sites.
- **Result 2: An increased number of local households will use bamboo as their energy source and an increased number of micro and small enterprises (MSEs) will produce bamboo charcoal.** The project will build the capacities of local households and target MSEs to replace wood with bamboo for firewood and charcoal production. The main indicators for achieving this result will include at least 20,000 households using bamboo for firewood, 13,000 households in Ethiopia and 7,000 households in Ghana; at

least 7,000 Ethiopian households and 3,000 Ghanaian households using bamboo charcoal; at least 1,000 MSEs, 700 in Ethiopia and 300 in Ghana, using bamboo for charcoal production.

- **Result 3: Both governments will have issued policy recommendations, and at least one national level MSE association in each country will be in place.** The project will develop policy recommendations on community-based bamboo firewood/ charcoal production through central government level discussions and seminar. These recommendations will be disseminated through workshops that bring together stakeholders of all kinds and at all levels. The project will also support the establishment of two bamboo charcoal MSE associations, one in Ethiopia and one in Ghana, and help set up a long-term plan for how to maintain each association after the project is over.

Possibilities for replication and extension of the project outcomes

Replicability is at the heart of the project action's design. The project's overall objective is to increase sustainable use of innovative biomass energy options in Ethiopia and Ghana for local populations in order to meet everyday energy needs. As such, the activities are seen as a first step to gain and apply knowledge on bamboo as renewable biomass energy in these socio-economic and agro-ecological areas. The project will demonstrate and disseminate best bamboo firewood and charcoal production technologies and develop policy recommendations and institutional support mechanisms necessary to enable bamboo for firewood and charcoal production to be undertaken economically, effectively and in a sustainable manner by local households and charcoal producing MSEs. The real key to the project's long-term success is in helping the Governments of both countries to mainstream the idea into the relevant policy framework, without which it cannot be adopted on a countrywide scale within the existing energy, forestry and environmental programmes. The various activities of the action have been designed to build upon and complement one another to achieve this replication. At the national and local level, the beneficiary-driven-ness and integrated involvement of Government, local households and MSEs, and forestry research centres will ensure strong ownership of the activities and will enhance the opportunities for replication to other urban cities and rural villages.

The involvement of INBAR and project partners, who will provide technical and marketing support for existing wood charcoal MSEs to replace wood with bamboo for charcoal production, will clearly demonstrate the income generation possibilities for using bamboo charcoal technologies, thus encouraging members of other cities and villages to participate and replicate these experiences. The environmental, technical, and socio-economic benefits will be documented and made widely available elsewhere as adaptable models. Development of supportive policy recommendations will facilitate greater uptake of the technologies and practices at provincial and national levels, and awareness raising of high-level decision-makers will foster effective replication at these levels. Involvement of stakeholders from all levels in the project steering committee will ensure dissemination of positive experiences within the mandated networks of these organisations and bodies.

The project has strong potential for further replication in sub-Saharan Africa, Asia and Latin America countries, which are dependent on wood-based fuels for cooking and heating homes. The overall objective is also highly relevant to neighbouring sub-Saharan African countries, such as Kenya, Nigeria, Mozambique, Tanzania, Uganda and Sudan, where there is clear need to adopt sustainable energy resources in preference to firewood,

which is responsible for significant deforestation, emissions, and indoor air pollution. Bamboo resources are also locally available in these countries. The results are expected to form the basis for an innovative biomass solution for sub-Saharan Africa's energy crisis in these countries, where, like in Ethiopia and Ghana, many households depend on wood-based fuels to meet their everyday energy needs.

The project will thus serve as a model for replication in these countries. Results and lessons learned in obtaining those results will show how access to information and know-how, institutional support systems for bamboo firewood and charcoal production, adequate communication among government, and civil society, MSE capacity building, adequate national marketing strategies, can ensure sustainability, supply and use of bamboo as biomass fuels. Results could also be replicated in Asian and Latin American countries as well other African countries where unsustainable use of wood-based fuels persists and bamboo resources are locally available.

Acknowledgements

We would like to thank the European Commission for funding our project. We also like to thank our partners of the project for their participation and contribution.

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Philippine Bamboo Innovation in Partnership with INBAR

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Summary and outcomes

The Community Enterprise Development Project, coined Design Center Philippines, was undertaken to investigate and implement new ways and processes of producing bamboo components and products with village level production as its focus. Thus, the project veered away from the use of heavy capital investment in machinery. Instead, thermo setting resins like polyester resins with fiberglass mats and hemp were introduced and integrated into the usual village outputs of bamboo culm slats, split halves, and woven mats to take these products into a different level of higher value products welcomed by furniture makers and home builders alike for use in resorts and natural homes in the Philippines and around the world.

The main research outcome are grouped into 12 process innovation technologies which open new and infinite possibilities for designers working with bamboo to benefit the rural poor who have been left behind in the 21st century. These innovations are:

Using Bamboo Woven Mats

1. One layer bamboo strips, woven into structural shapes such as baskets and furniture leg components, woven on desired moulds, then released, and laminated one side with fiberglass, make structurally sound seats, chairs and hollow furniture components of all sizes and shapes. This technology innovation opens a variety of ways bamboo can be shaped into furniture and home accessories for functional use.
2. One layer bamboo strips are woven into fiberglass chair molds, leaving the fiberglass mold inside and injected with polyester resin to bind the two making beautiful woven chairs of any size and shape structurally sound. A series of chairs were made to illustrate this.
3. Two layer woven bamboo mats sandwich with fiberglass woven mats and polyester resin were molded into one piece all woven bamboo mat stackable chairs, seats and backs replacing molded plastic chairs, seats and a multitude of containers;
4. Intricately woven and colored open weave bamboo mats were sandwiched between 2 fiberglass woven mats to make into light diffusers woven and decorative skylight roofing sheets. This technology opens a multitude of possibilities for lighting fixtures, diffusers and bathroom wall tiles;
5. One layer closed weave finely woven bamboo mats were laminated with fiberglass mats and polyester resin and shaped into counter tops for bathrooms and kitchen; the same technology uses the closely woven fine bamboo mats as table tops, and decorative wall panels and opens the door to a multitude of home accessories.

Using Bamboo Rotary sliced Veneer promoted by the Department of Science & Technology of the Philippines

6. Rotary sliced bamboo veneer strips were cut to desired widths and shaped into honeycomb core boards and honeycomb furniture components using polyester resin. Endless housing structural components and furniture configurations can be made with this technology especially if used with even cheaper environmentally sound glues found in India coming from cashew.
7. Rotary sliced bamboo veneer strips used in the past for panel facing or pressed into mat bowls, trays, plates, and spoons were stripped into 2 inch widths and laminated successfully with polyester resin to any length and shape to form structurally sound furniture components replacing steel and wood. This opens immense possibilities for bamboo in furniture bringing it to the 21st century. Two types of prototypes were produced to illustrate this: stools and stackable chairs.

Using Thin-walled Bamboo culms

8. Thin walled bamboo culms are split into 3 parts and laminated back to back with resin and hemp into thin lightweight furniture components structurally sound. This opens large possibilities for designers to use bamboo in furniture. Two types of prototypes were made to illustrate this: a series of folding chairs with canvas and stackable chairs with woven mat seats.
9. Thin walled bamboo components are split into 2 parts, crushed, bent and laminated back to back with polyester resin and fiberglass mats to make into structural building and furniture components. Here again infinite possibilities have opened to designers in using bamboo for furniture and building components. Two types of prototypes were made to illustrate this: outdoor lounging chairs and floorboards for decks.

Using Typical Bamboo Slats

10. Bamboo slats were assembled into 1.2 m x 1.2 m panels held together with paper then laminated with polyester resin into 10 mm plywood boards to avoid warp age. This enables the village workers to supply finished flooring material to the market without heavy investment in machinery.

Glues

11. The use of polyester resin with fiberglass woven mats or hemp in these processes brings the component to the outdoors. The initial trials were not sound. Repetitive experiments perfected the proportions, combinations and processes used. Other thermo setting glues that are cheaper should be looked into especially those coming from India.

Finishing

12. The use of stop sag with gel coat resins as clear putty or fillers and gel coat as clear primers for finishing bamboo is a breakthrough in finishing technology for bamboo products. It not only brings the product outdoor but brings the quality level of the product into the high end market. Many techniques and processes were tried over and over again to finally determine how to finish bamboo properly.

Penetrating wood stains are sprayed on to color the bamboo after the primer. The gel coat is again sprayed on top on the color to seal it. Then a mat finish polyurethane coat is sprayed for the final coat. This finish puts bamboo at par with all high end wooden furniture.
Note 1: Spray painting should be done using air operated piston pump compressors and airless spray guns to get the proper thickness per coat of application. Otherwise the resins need to be diluted and are not that effective outdoors. Lack of access to such equipment during prototyping prevented us from testing the product under different harsh weather conditions. We have however tried the unit in a demo and tested the usage of paints. It is less durable than half of conventional standards.

Note2: we have not yet been successful in finding color fast stains to withstand the tropical sun. More experiments still need to be conducted.

Though more studies are required to be undertaken to commercialize the production of these technologies, attached drawings give one an idea of products that can be developed along the lines of furniture alone.

In addition to the innovations presented, a drum pyrolyzer with 40% recovery was fabricated in collaboration with the Cottage Industry Technology Center and Forest Products Research and Development Center to turn bamboo waste into charcoal. This has helped every household engaged in bamboo production to turn 70 kgs of waste every week into 240 pesos, adding to their income stream.

The Context

In Abra, Philippines, the number of households involved in commercial use of bamboo is around 1524, with 930 households concentrated in 18 villages (6 municipalities). This amounts to about 4572 people assuming that per household 3 people are actively involved in the industry.

Each household generates around 70 kgs of bamboo waste every week producing bamboo furniture and barbecue sticks for the local market. Turning the waste into charcoal to add to their income stream was priority.

Most of these producers would supply the export market through traders in the past. However with China's entry into the market, most export orders stopped due to China's ability to provide the world with high quality commercially produced bamboo products at the right price. In addition, these producers have been left behind by the 21st century as new innovations in materials like plastic, having low maintenance and all weather qualities, have taken the place of indigenous materials like bamboo and rattan with look-alike products catering internationally to resorts, spas and outdoor furniture.

However, with problems arising from global warming, much interest has been aroused again on sustainable materials such as Bamboo. People are beginning to ask again if the materials used are sustainable. With this opportunity at hand, the task was to investigate new ways of how bamboo products could be produced in village level workshops at the right price for the 21st century market - taking advantage of the boom in resorts and return to natural homes. In the province of Bohol alone, known for its eco tourism, ten thousand resort rooms need to be built till the year 2010. At current cost of one million pesos a room, this translates to 10 billion pesos

for one province alone in the Philippines. There are at least nine other similar destination provinces being sold by the Department of Tourism. The other markets with bright future are school desks and classrooms.

Craftsmen from other parts of Asia and Africa are feeling very similar problems and opportunities. Thus it was thought that new processes need to be found to keep bamboo craftsmen busy in the 21st century and the Philippines was in the best position to do so.

The decision to conduct the research in the Philippines is threefold: the Philippines international leadership position in design excellence; its technical expertise in developing new products and processes with focus on indigenous materials; its experience using village level workshops for its export industry.

Scope of Replication

The innovations in this study were designed to rely on the village craftsmen for most of the primary processes with exception of veneering. It also relies on the village craftsmen for producing the mats in mass with the help of patterns and moulds. It also continues to rely on the bamboo producers to cut, split, and strip bamboo culms to desired component specifications.

These components are brought to a factory in the midst of a village cluster where they undergo curing, veneering, crushing, bending, drying, lamination, and some finishing and assembly. The factory's clients are different furniture makers, home builders and home depots that in turn assemble, finish, and deliver the final product to their clients/outlets.

At the center of these operations is a core group whose function it is to continuously market, research and develop new products and processes through the collaboration of the village craftsmen, the factory, and the furniture/ home designers + makers. External collaboration shall be provided by Suppliers of different materials and equipment, the Local Government Units and Indigenous Institutions, the Bamboo Industry Cluster Committee and the Philippine Bamboo Network.

Main Players

a. The Bamboo Producers + Harvesters + Carriers
b. The Village Craftsmen
c. The Factory (a partnership of InHand Abra and InTechDev)
d. The Home accessory + Furniture makers and Home + Resort Builders
e. Home Outlets + Building Contractors and its Clients
f. Suppliers of Glues + Resins + Moulds + Equipment
g. Provincial Bamboo Industry Cluster Committee (PBICC)/ Philippine Bamboo Network
h. Local Government Units and Indigenous Institutions

Scaling Up

A factory in the midst of a village cluster, equipped with the right equipment such as curing, cutting, and veneering equipment, presses and moulds, and finishing equipment. These can be scaled up depending on the type of products it needs to do and market requirements per Region.

Scaling Out

Bamboo village craftsmen exist in every Region in the Philippines doing similar bamboo products. Depending on a Region's requirements, a factory brought in the midst of a village cluster could replicate similar or the same products through the collaboration of the bamboo producers, village craftsmen, the factory and the furniture makers/ home builders/outlets. Equipment can be fabricated or funded with the collaboration of the Technical Education Skills and Development Agency, the Department of Science and Technology and the local government units as in the case of their collaborated efforts to fabricate more drum pyrolizers in Abra after the successful demonstration of the first unit.

Main Technical Components of the Program

a. Process design – designing processes with focus on the village craftmen capability to produce products for the 21st century market at the right price, quality and time. This necessitates collaboration among the bamboo producers and craftsmen, a technically capable factory which can operate at village level and furniture makers and home builders who market their own products to the 21st century market.
b. Product design +Prototype – fast prototyping technologies linked to market requirements
c. Mould design + execution – efficient and cost effective mould materials and production
d. Material Preparation + Weaving on Moulds or following Patterns - computer aided programs to produce patterns from 3 d drawings.
e. Veneering + Drying + cutting – veneering and drying equipment to prevent mould and cut veneer strips into specified widths and lengths.
f. Glues + Resin Lamination – environment friendly thermosetting resins and needed fibers for maximum strength.
g. Connectors + Hardware + Assembly – bamboo, because of its nodes, unlike wood is never the same and difficult to mass produce.. thus assembly becomes a challege.
h. Dyes + Paints + Resins + Painting Equipment – color fast dyes for the tropical weather; colorless resins top coats to help keep colors fast and moisture out; airless spray paint equipment that allows the thick application of the resin.
i. Charcoal drum pyrolyzers – efficient recovery of waste material at village level.

THE INSTITUTIONAL CONTEXT

In 1988, InTechDev Systems, InHand Abra and the National Livelihood Support Fund collaborated to bring development in the province of Abra thru a seed project using thin walled bamboo which was then abundant in the province, and developed by Intechdev into bamboo plywood panels with trade name "plyboo". The project was paralyzed in 1989 due to the earthquake that devastated the province cutting off the raw material supply. Despite that, the panels were continually being promoted, tested and used successfully in a low cost housing model - the Pinatubo House in 1990. The supply problem was never resolved and finally dwindled when the bamboo in the uplands flowered a few years later mothballing the project altogether in 1996 for lack of material supply.

InHand Abra then concentrated on working with village craftsmen to scale up their facilities and know-how. These village craftsmen are presently very successful on their own and their facilities demonstrating 'industrialized-handicraft' seen in the town of Bumagcat, Tayum. However, few have followed their footsteps as the exports orders for craft items slowed down since the emergence of China in the industry. Seeing that a return to industry was a key factor to develop the bamboo industry, InHand Abra represented by Carmelita Bersalona partnered with INBAR to get funds to restart the plyboo project in Abra and became the **A**ction **R**esearch **S**ite (ARS) of INBAR in the country.

Carmelita Bersalona, began to assist INBAR in its livelihood projects in Africa and India in the year 2005. It began to dawn on her that the problems of craftsmen in third world countries was universal – the craftsmen received less than a dollar for a day's work, unable to sustain their own needs, yet, at the same time, their products were priced high compared to that of China's. It seemed clear from her visits to other countries that setting up common facility centers alone was not the answer to alleviate the problems of the craftsmen.

In 2005, InHand Abra and Intechdev jointly wrote a proposal to ITTO to investigate new ways of producing bamboo products for the 21st century market with focus on village level workshops and craftsmen. The proposal was approved but no funding was available. In 2006, funding from IFAD through INBAR for InHand Abra to finally start the much needed investigation and study of new processes began. Medilen Singh of Intechdev partnered with InHand Abra to direct the process and development of process innovations.

On the other hand, through the management of InHand Abra, the INBAR **G**lobal **M**arketing **I**nitiative (GMI) Design Centre has collaborated with the *Department of Science and Technology* to develop other bamboo processing technologies. For example, the Design Centre, working in tandem with the *Forest Products Research & Development Institute*, has contributed towards the development of bamboo charcoal and veneering technologies. In collaboration with the *Philippines Textile Research Institute*, the Design Centre has also developed bamboo fibre processing technology, which can be applied to furniture making. All these have been used by Intechdev in its process innovations.

PROGRAMME IMPLEMENTATION

The challenge was to find appropriate methods to enable bamboo producers to continue with their craft but at the same time answer the needs of the local and international market in the 21st century.

The idea was to let go of the notion that more machinery meant better products.

The Philippines has the highest cost of electricity in the Region and supply is not stable in poor communities. Also, producing weather resistant products meant the use of resins for glueing and protection.

A trip around the various research and development agencies of government showed the problem of using stripped bamboo for lamination. Failure was in the glue line despite the use of polyurethane glues due to the absence of appropriate processes. Standard thickness of bamboo strips was critical to the process for proper

bonding. Also critical was the use of proper jigs and clamping system. The down side also was the cost of polyurethane glues which sell at 800 pesos a liter.

To test different resins, woven mats were used to make into waterproof boards and furniture. Polyester resins proved to be the best suited but not friendly to the environment but the aesthetic results were wonderful. However, future collaboration with the manufacturer resulted in environmentally friendly resins that are water based. The first board produced was left outdoor for 2 months for testing. The only thing that changed after 2 months was the color of the bamboo mat that was dyed. Polyester resin proved to work well with bamboo. It is the most inexpensive of thermo setting resins. It sells at 127 pesos a liter. The board may be used for ceiling diffusers and as a substitute to bathroom tiles and kitchen countertops. If we find a UV protective treatment to keep the colors fast despite the light, the board can be used as roofing sheets for certain areas like patios.

An alternative to using bamboo strips for furniture component is the use of rotary bamboo veneer and at certain cases combined with sliced bamboo veneer. Rotary cut veneers come in standard thickness and pliable enough to be shaped into different forms. However, it has a limitation on length, 57 cm., but can be stripped with paper cutters and taped to desired lengths.

The resin is mixed with a hardener and brushed onto the strips. The strips are laid into desired moulds or jigs and clamped manually. The outer strips may be made of a sliced veneer so as not to show the joints of the veneer taped together. The setting of the resins is completed within 20 min and removed from the mould. The piece is then weather resistant as it is sandwiched in resin. The piece is allowed to cure overnight then sanded and finished with polymer gel coatings or clear polyurethane paints. Parts maybe welded together also using the resin instead of metal hardware. The process is simple but requires highly precise craft skills that may be learned.

Another process innovation is the utilization of bamboo with 3.5” diameter and more than ¼” thickness and with long internodes. The bamboo culm is cut into cylinders according to specified sizes, scraped, split/ripped and planed into desired width and thickness and laminated back to back with polyester resins to desired shapes clamped in moulds. Preparatory to lamination, heat bending is done then clamped till cool for the required shape to stay. For its seat and back rest, crushed bamboo or laminated woven bamboo/fiber mats are utilized.

The production process of bent bamboo furniture was refined and proper jigs and moulds developed and tested on new designs for patio furniture. These were exhibited during the International Bamboo and Rattan Exhbition in Guangzhou, China on September 22-24, 2007.

Crushed bamboo laminated back to back into decking boards using resin and fiber mat in between was very successful. After 3 months of water test, the glue line held nicely. However, during the test against severe tropical sunlight, the bamboo cracked at the surface within a week much like pine wood decking boards do. The thinly coated resin surface gave in and peeled off. We need to apply the resins properly with airless spray units to get the required thickness on the surface before doing further tests again. If it persists, then the thing to do is to use oil based weather resistant coatings like xyladicor to protect the bamboo decking boards from the weather, and repaint every 3 years.

Impact

The Process innovation of combining bamboo veneer, bamboo splits, crashed bamboo and polyester resin, brings bamboo into the garden furniture category and building materials resistant to weather. It allows for indoor and outdoor use of the furniture and building components which is the clamor of the market today for aesthetics and easy maintenance. It will allow bamboo to compete with imitation bamboo and rattan furniture for outdoor using aluminum and plastic fiber imitations. Not only is bamboo used for esthetic purposes but is also used for structural purposes with respect furniture and building components. It does away with metal for structural components.

The process innovation will also provide the Bamboo Industry in the Philippines with a chance to develop and grow using the process to supply the furniture makers with components they need to compete internationally.

Constraints Faced During the Program Implementation

Internal

- Workplace was too small and affected by changing weather;
- Equipment such as dryers, presses, cutting tools and proper painting equipment were lacking or make shift;
- Jigs were temporary and made of wood;
- Pace was slow as each experiment went through tests before proceeding to next phases.
- Each phase went through as series of trial and error procedures for process elimination as there were no models to follow.

External

- Lack of color fast dyes
- Lack of technical data on resins and glues
- Lack of inexpensive glues in the market especially thermosetting glues
- Lack of equipment facilities to rent such as new types of airless painting equipment necessary to test the weather resistant qualities of the products.(Because of this lack, we are unable to test whether our present coatings can withstand the severe heat of tropical sunlight and continuous rain and heat conditions)
- Lack of testing equipment to expedites test results such as the effect of UV rays.

Further Research Needs

For furniture and building materials, the production processes still need to be refined with proper presses, jigs, moulds, spray equipment and knock down hardware developed and tested before actual building of prototype house can take place. Its outcome will be the final costings and equipment listing before commercialization of these processes can take place.

Target Group

The projected commercialization of the bamboo furniture at the village level using the new innovations shall involve 96 households from two weaving villages of La Paz (Mudeng and Udangan) with an average annual income of Php 34800 and 59 households from the village of Bugbog, Bucay and Bumagcat, Tayum which has some basic machines and tools for semi-processing of bamboo. The bamboo producers of Tayum earn an average annual income of Php 79500 which is attributed to semi-mechanized production. The indigenous peoples of Licuan-Baay and Sallapadan will be tapped to supply crashed bamboo.

The Gender Dimension

In every household at least one woman is involved in the production of bamboo components. Historically, the women of the household hold the purse. She markets the products and manages the income of the household. Thus, in this case, at least 155 women will be involved at the village level.

In the factory, most of the workers in the assembly section will be women earning at least minimum wage.

Accessibility

The innovations made in this action research will be learned and demonstrated in the factory to be established in village clusters. It will be open to INBAR's network of member countries.

Institutional Sustainability

The factory will operate directly at the community level. It will buy the products from the craftsmen, therefore, it needs to set up and train them well with respects processes and equipment if it wants quality products delivered at the right price. The factory will be a joint venture of Intechdev and InHand Abra in partnership with INBAR - one having the expertise of technology transfer, the other, community development.

Dissemination Pathways

Communication Strategies at the Village Level

1. Collaboration with the Provincial Bamboo Industry Cluster Committee (PBICC) which plans, coordinates, implements and evaluates programmes that strengthen development of the bamboo sector. The PBICC,chaired by the Provincial governor and co-chaired by the Department of Environment & Natural Resources and the Department of Trade & Industry, draws membership from a wide range of government, technical and financial institutions. Members of the PBICC include the Department of Agrarian Reform, the Technical Education Skills & Development Agency, the Department of Labor & Employment, the Technology Livelihood Resource Development Center, the Department of Science & Technology, the Cooperative Development Authority, the Department of Local Government, the Land Bank of the Philippines, the Department of Education and Culture, and the Abra State Institute of Science & Technology. As of 2007, the PBICC has increased its membership with municipalities engaged in bamboo production and, or processing now being represented.

2. Coordination with indigenous leaders/institutions and local government officials on policies related to bamboo harvesting and infrastructure development

3. On site consultations including design clinic

4. Training cum production schemes

5. Provincial and regional trade fairs

6. Communication through SMS messages and email

Communication Strategies at the National and International levels

1. National and international trade fairs

2. Collaboration with government agencies :

a. the Department of Science and Technology to produce a number of new bamboo processing technologies. For example, working in tandem with the Forest Products Research & Development Institute, it has contributed towards the development of bamboo charcoal

b. the Philippines Textile Research Institute, the bamboo fibre processing technology applied to furniture making

c. the Department of Trade & Industry on new product designs that will increase access to growing domestic and international markets; marketing research by the Bureau of Domestic Trade, which supplies designers with details on the latest consumer trends and material developments; new product designs to be exposed to markets through the Center for International Trade & Market Exposition.

3. ECO Network compose of individual designers, social enterprise developers, manufacturers, and exporters bridging community producers with technology, design and market.

4. Philippine Bamboo Network, Philippine Bamboo Foundation and other NGOs in the development of the Philippine Bamboo Industry.

The Bamboo Sector as an Effective Stakeholder Network and the Role of INBAR

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Introduction

Bamboos grow naturally in almost all tropical and sub-tropical countries, except those in the Persian Gulf, North Africa and the Sahel, and extend well into the temperate zones of each hemisphere. Many societies have developed integrally with bamboo, and the ubiquity and utility with which bamboo is relied upon by people in over half the nations of the world for varied aspects of their lives is well documented. Cultures have evolved with bamboo, and it has been a significant contributor to the development of civilization.

With perhaps a billion of the world's population relying on bamboo in some way or another for some aspect of their lives or livelihoods, the vast majority of those poor and in developing countries, the opportunity that bamboo offers to improve their situations by building on inherent bamboo skills and knowledge is huge. Already, innovation of products, policies and support structures have led some countries, particularly China, and to a lesser extent India, Colombia and the Philippines amongst others, to develop thriving commercial bamboo sectors that employ millions of people.

Because of the versatility of uses of bamboo wood, the production chains of bamboo for different products often involve a range of people at different stages, each stage a different processing step, and each step involving value addition by the producers, and hence income generation. As a result the value chain of bamboo products is very pro-poor. Even with products that are finished in large factories, much primary processing is required and is usually done by the farmers that grow and harvest them or in their communities, which not only benefits the processors, but is usually cheaper for the factory owner as they can work with semi-processed materials. A production chain can thus involve many stakeholders, from individual farmers to NGOs supporting their work, funding agencies such as banks, commercial companies, government agencies from forestry departments to ministries of commerce, chambers of commerce, fair trade groups, all of which have varying roles within it.

The environmental benefits of bamboo in relation to coping with climate change are presently very topical - annual non-destructive harvesting of bamboo means that the canopy is retained over the soil and permanently and significantly reduces soil erosion, whilst providing a predictable supply of wood for income generating activities. Bamboo's very rapid growth rate means it sequesters carbon rapidly, though the extent to which this happens needs further research (Liese, in press). Most high-value bamboo products have a long life, and the carbon can be captured and held for many decades. As an alternative to timber wood, using bamboo would help

reduce the destruction of forests, particularly tropical forests - activities which in themselves release large amounts of carbon.

At the Conference on "Climate Change, Global Risks, Challenges and Decisions" in Copenhagen in March 2009, noted Climate Change specialist Prof. John Schellnhuber said: "We are facing the MAD challenge: Mitigation, Adaptation and Development" (see http://climatecongress.ku.dk/). He argued for holistic approaches, not marginal changes, that actively involve developing countries – and the vast majority of these already have bamboo. The inherent ability of bamboo to combine protection of the environment with income generation ensures it is a strong candidate for contributing to these holistic integrated development systems that will be necessary for dealing with the MAD challenge. At the same time, researching and implementing holistic development systems can only be successful through a partnership approach.

INBAR as a networking agency

A good partnership brings together organizations and individuals with similar goals but different and complementary skills, which ensures more effective and efficient progress towards their common aims, and enables them to learn together, and from each other. Partnerships are often formalized by an MoU indicating a general agreement to work together, or by a contract in order to implement a project or other activity. In the latter case, careful inclusion of appropriate technical, national/local support, field implementation, innovation, marketing, training organizations (amongst others) at appropriate levels – international, national, local or community – can build strong links that increase local and national capacities to implement the project, to continue its development or adapt it for broader uptake after the project has finished.

The different levels of knowledge and awareness of what bamboo can do across the world is vast. INBAR often finds that when we bring people from countries with untapped bamboo-based development potential to China to see the bamboo value chain, or to our Action Research Sites in Asia, Africa or Latin America, they are amazed at the possibilities bamboo has to offer. Unless specific action is undertaken, ideas and innovations tend to remain where they originate and with the people who originated them. This is to be expected particularly in the case of new products where many have a financial value. Clearly sharing of information across boundaries, be they national, cultural, economic or social, is an essential first step to enabling decision makers to decide whether and which bamboo-based solutions to trial in their own regions. Linking appropriate partners to the decision makers and the implementers to help them achieve their bamboo-based aims is the second step, and providing guidance and assistance to enable them to achieve these aims is the third.

Recognizing the essential need for sharing and enhancing existing skills and experiences from the very diverse backgrounds from which they come in order to grow the world's bamboo sector, INBAR was established to act as the hub of a network of bamboo expertise, implementation, adaptation and adoption organizations and individuals. This confers certain advantages, responsibilities and ways of working on INBAR. Firstly, networks, and the partnerships that develop from them, enable learning and innovation amongst their members – sharing of information and skills increases the abilities of members, and builds stronger partnerships between them. This leads to increased mutual trust and support that strengthens the network, including sharing information that would not otherwise be shared. Finally, networks and partnerships lead to an increased capacity to manage

change by the members and empower them to deal with the broader, more complex issues that affect their common interests (Svendsen and Laberge, 2007).

Over the years INBAR has formally partnered (ie by MoU, contract or similar agreement) well over 200 organizations, companies and individuals for its work, and worked informally with many more. Our mailing list includes over 5500 institutions and individuals throughout the world. As a hub, INBAR aims to collate and provide up-to-date information on all aspects of bamboo-based development to the world community, and we are continually working to improve our information services. INBAR coordinates a range of training and awareness- raising activities, focusing on its abilities as a global networking organization to share skills across national and continental boundaries. INBAR also needs to lead the development of innovative bamboo-based solutions to poverty and environmental amelioration, and runs Action Research Projects to do this. Not only do they trial the production of bamboo products in different locations, with different bamboo species, under different environmental, social and market conditions and different levels of policy support and investment, but they also trial different partnerships and show how they can work for sustainable development. INBAR shares the experience gained to guide and help other members of the network achieve similar success.

INBAR's partners

The world's bamboo sector is very diverse. Within the sector, different sets of stakeholders have different demands, and so INBAR works to develop sub-networks where appropriate, sometimes thematic, sometimes geographical, that bring like-minded stakeholders together. In general our main groups of stakeholders can be categorized as:

- The approximately one billion rural poor people who depend in some way or another on bamboo for some or all of their lives and livelihoods
- The governments of INBAR's member countries and, by default, all their citizens (ie. over 3 billion people)
- The consumers of bamboo products throughout the world
- Actual or potential investors in the bamboo sector
- Bamboo innovators and implementers
- The world's development community

INBAR has developed formal structures for some of its partnerships:

Membership

Membership of INBAR is open only to sovereign states registered with the United Nations. Nine states signed INBAR's establishment treaty in 1997, and presently 34 states have acceded – 10 in Asia, 13 in Africa, 9 in Latin America, one in North America and one in Oceania. Membership of INBAR confers certain advantages on these states, but also requires their commitment to helping INBAR develop for the good of their own citizens. Representatives of the Member Countries meet once every two years as the INBAR Council to review INBAR's progress and take decisions about its future.

Affiliates

INBAR's affiliates scheme, with about 170 members, is regarded as a second tier of membership, and is open to individuals and organizations alike for a small fee. It offers a range of benefits to members. The scheme in Latin America is particularly successful, and acts as a network of geographically and culturally-similar partners, sharing a common language.

Partnership programmes

INBAR runs three thematic programmes and also three special partnership programmes – the NTFP Global Partnership Programme (NTFP-GPP), the Global Bamboo Housing Programme (GBHP) and the Global Rattan Programme (GRP). These are multi-level partnerships that work with stakeholders ranging from governments (eg. for policy, investment) to NGOs (eg. for community training or access to common-use processing facilities). They work by either encouraging formal membership of organizations in the partnership, and/or by being open to individuals and institutions via memberships of online discussion groups.

The NTFP-GPP was established under the aegis of the Global Forum on Agricultural Research in 2005 and currently has 22 members, including the governments of India, Mozambique and Ecuador, SNV - the Netherlands Development Organization, the Asian and Arab Networks for Sustainable Agricultural Development, and a range of NGOs and companies. Its goals are ensconsed in the Marrakech Declaration, and it aims to promote collaborative efforts, synergies and economies of scale to address strategic NTFP research and development issues of global relevance in order to contribute to achieving the Millennium Development Goals. Projects to date have included evaluations of NTFP potential in Mozambique and reviews and policy work of charcoal production and use in Africa. The NTFP-GPP helps the INBAR network to learn from other NTFPs, and the NTFPs represented by the GPP members learn from INBAR's network to improve their effectiveness.

The Global Bamboo Housing Programme aims to promote and develop appropriate sustainable housing solutions using bamboo. With a global need for 4000 new houses every day, pressure on timber and the rising costs of mineral-based raw materials, the programme and its partners have demonstrated bamboo as an effective alternative resource for construction in a number of countries in Asia, Africa and Latin America. The programme has trained hundreds of house constructors, fostered innovation of new housing construction systems using engineered bamboo, and developed support systems such as standards for building with round-pole bamboo that can be used to develop national legislation that provides a legal framework for builders of bamboo houses. With its partners it has innovated a prototype refugee shelter from bamboo in Ghana, and built emergency shelters in Sichuan after the earthquake in 2008. The programme has organized two international workshops on housing and has organized a highly acclaimed design competition (see Xiao *et al.* 2008; Paudel *et al.* 2008). The programme presently supports projects to develop modular bamboo housing production facilities in Nepal and Ethiopia, to develop pre-formed bamboo components and relevant policy supports in India, and has started working on bamboo housing more widely in East Africa. Its thriving Google group is a forum for discussion and exchange amongst individuals and institutions, with well over 150 members.

The Global Rattan Programme commenced in 2008, and has a specific aim to foster links between Asia, Africa and Latin America. Currently it runs its first project in Ghana. It is presently an informal network, and not

directly relevant to bamboo, expect for the fact that in a significant number of countries the bamboo and rattan sectors are very much intertwined.

As part of its core activities, INBAR runs to develop innovative and sustainable solutions to environmental degradation, poverty and fairer trade with bamboo, in partnership with a wide range of expert organizations and individuals. Project partners are a.o. multilateral agencies, funding agencies, government departments, NGOs, research and development agencies, community-based organizations, and marketing organizations.

Impact of INBAR's work

INBAR's work aims to contribute to the United Nations Millennium Development Goals, particularly MDG 1 (eradicate extreme poverty and hunger), MDG 7 (ensure environmental sustainability) and MDG 8 (develop a global partnership for development). To ensure that INBAR works effectively, INBAR developed four strategic goals in 2006 that it aims to achieve over the following decade (INBAR, 2006):

1. An expanded, highly effective network of committed stakeholders (MDG 8)
2. Better ways and means of livelihood development, particularly in rural areas (MDG 1)
3. Increased and more effective conservation of the environment and of biodiversity (MDG 7)
4. A better and more innovative market environment, providing fair global-to-local and local-to-global trading systems for income generation (MDG 8)

INBAR with its partners is making good progress towards realizing its goals.

MDG 1: Eradicate extreme poverty and hunger

Directly improving the lives of thousands of people in Asia, Africa and Latin America in development projects

INBAR and its partners work with a small but representative sample of the rural poor in our field projects to develop replicable and adaptable development models with bamboo and rattan that can be scaled up and applied more widely. We have helped thousands of men and women in the Action Research Sites earn incomes from bamboo, and have developed a Global Marketing Initiative to promote better products that meet international market demand, to help increase the benefits they accrue from their work (eg. see Ramanuja Rao *et al*, in press)..

Helping innovate bamboo technologies and products with market potential

INBAR and partners have fostered the development of a wide range of new products, and the systems used to produce them, including flat-pack bamboo furniture, bamboo crisps, stylish round-pole furniture, mass produced incense sticks and commoditized bamboo laths and slats, all of which meet market demand, or open up new trading avenues.

Training over 6000 people in bamboo production and processing

INBAR run training courses with partners in all developing continents. Many trainees use their new skills to establish businesses or take jobs in the sector. Courses targeted towards government decision-makers have encouraged some of them to develop national bamboo-based development programmes and projects in their own countries.

MDG 7: Ensure environmental sustainability

Demonstrating bamboo for rehabilitating degraded lands and preventing soil erosion

The bamboos that INBAR supported the NGO "UTTHAN" to plant on land severely degraded by mining for brick making in Allahabad, India raised the water table by 7m in five years. In only two years bamboo plantations in China reduced soil erosion by 75% whilst providing incomes to local people who processed them for sale (see Kutty and Narayanan, 2003).

Evaluating the state of the World's bamboo resources

INBAR and FAO have agreed to include bamboo in FAO's pentennial Forest Resources Assessment, which will give a more accurate picture of the state of the world's bamboo forests. We estimated global bamboo species diversity and highlighted threatened habitats and species with UNEP(see Bystriakova *et al* 2002).

Demonstrating new conservation techniques

With local partners in Sichuan, Yunnan and Hunan provinces in China, INBAR has innovated new conservation techniques for endangered bamboo stands that improve productivity whist protecting the forest, and together we are developing a management standard to enable replication.

MDG 8: Develop a global partnership for development

Facilitating development of national and local institutional support systems in nine countries

Through our development projects we have fostered the development of bamboo based NGOs in INBAR member countries, such as Ecuador, Ghana, India, Tanzania, Ethiopia and Mozambique and helped facilitate government bamboo initiatives in India, Ghana and Mozambique that are now leading the development of the sector in these countries.

Developing standardized customs codes for more accurate reporting of bamboo and rattan trade, and an online trade statistics database

We worked with the World Customs Organization and other partners to produce bamboo specific categories and codes that are being used to track international trade more accurately since 2007. The INBAR online bamboo and rattan trade database provides easy access to the data.

Developing building codes for bamboo structures

Bamboo building codes for round pole houses have been adopted by the International Standards Organization and provide a basis for developing national legislation for bamboo buildings (see Anon, 2004). The GBHP is presently working on similar codes for engineered bamboo buildings.

Promoting commodity-based development

As the International Commodity Body for Bamboo and Rattan of the Common Fund for Commodities, INBAR facilitates the development and implementation of many bamboo commodity-based projects that help our member states develop bamboo and rattan as viable market-based options.

These achievements would not have been possible without the networking approach. We like to believe that the work done together not only has had real impact in the communities and on the environment, but that it also has grown all the partners involved, helped partners to learn from each other, and made all better at doing development with bamboo. Further development of the network is essential, as more and more organizations are seeing the possibilities of bamboo. Meetings such as the World Bamboo Congress are excellent opportunities to re-connect with many partners, to link in with new ones, and we look forward to working in an even more close partnership with the bamboo sector, not least so we can respond effectively to the MAD challenge.

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Bart DEWANCKER, Toshiichi KUSABA The preservation of bamboo forests undertaken by NPO Kitakyushu Biotope Network Group in Kitakyushu, Japan.	Bart Dewancker Associate Professor The University of Kitakyushu Hibikino 1-1 Wakamatsu-ku 808-0135 Kitakyushu Japan bart@env.kitakyu-u.ac.jp
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Shozo Shibata Succession of Bamboo (Phyllostachys bambusoides Sieb. et Zuc.) Riparian Forest Vegetation after Gregarious Flowering	SHIBATA, Shozo (Dr. Agr.) Professor Field Science Education and Research Center (FSERC) Kyoto University TEL:+81-(0)75-753-6442 FAX:+81-(0)75-753-6451 EMAIL:sho@kais.kyoto-u.ac.jp
Kananbala Sarangthem Cyanogenic Glycosides in Bamboo Plants Grown in Manipur, India.	Dr. Kananbala Sarangthem Assoc. Prof., Dept. of Life Sciences, Manipur University, Canchipur - 795003 Manipur, India kananbala_s@rediffmail.com
Keshab Shrestha The First Report of Flowering and Fruiting Phenomenon of Melocanna baccifera in Nepal	Keshab Shrestha Natural History Museum Swayambhu Kathmandu Nepal keshab_shrestha@hotmail.com
S. Pattanaik and J.B. Hall Species Relationships In Dendrocalamus Inferred From Aflp Fingerprints	Swapnendu Pattanaik Scientist, Rain Forest Research Institute (ICFRE) Jorhat, India. swapnen@yahoo.com J.B. Hall Director, Postgraduate Studies, School of the Environment & Natural Resources Bangor University, United Kingdom
Yoko Hisamoto and Mikio Kobayashi Flowering gene expression in the life history of two mass-flowered bamboos, Phyllostachys meyeri and Shibataea chinensis (Poaceae: Bambusoideae)	Yoko Hisamoto United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, 3-5-8, Saiwai-cho, Fuchu, Tokyo, 183-8509 JAPAN da07953001@cc.utsunomiya-u.ac.jp Mikio Kobayashi Department of Forest Science, Faculty of Agriculture, Utsunomiya University, 350, Mine-machi, Utsunomiya, 321-8505 JAPAN
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Abhinav Kant Micropropagation protocol for Melocanna baccifera using nodal explants from mature clump	Abhinav Kant Research Scholar Tissue Culture Discipline Forest Research Institute Dehradun, India Email: akant23@gmail.com
Celso B. Lantican Bamboo Propagation: Practical Experiences of Some Private Nursery Operators in Laguna, Philippines	Celso B. Lantican President, Bamboo Network of the Philippines Retired Professor and Former Dean UPLB College of Forestry The Philippines cblantican@gmail.com
Sheena Haorongbam, David Elangbam and C. Nirmala Cyanogenic glucosides in juvenile edible shoots of some Indian bamboos	Nirmala Chongtham Department of Botany Panjab University, Chandigarh, India e-mail: cnirmala10@yahoo.com
C. Nirmala, Abdulminam Hussein Ali , Badal T, M.L. Sharma In-vitro organogenesis and simultaneous formation of shoots and roots from callus in Dendrocalamus asper	Abdulminam Hussien Ali Ho. no. 212 sec 11 A Chandigrah, India. masaowdi_67@hotmail.com
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Gladys Muivah, Rashmi Verma & I.Usha Rao Allelopathic effect of Parthenium hysterophorus L. on germination and growth of seedlings of Bambusa bambos (L) Voss and Dendrocalamus strictus Nees	Gladys Muivah, Rashmi Verma & I.Usha Rao Department of Botany University of Delhi Delhi-110 007 India E-mail: usharaolab@yahoo.com
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Th.Brojendro Singh Bamboo – A Renewable Natural Resource And Valuable Raw Material Of Cottage Industries	D.M. College of Science Manipur India drthbrojendro@gmail.com
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