

ADOPTION OF BAMBOO IN GHANA'S FOREST PRODUCTS
INDUSTRY: AN INVESTIGATION OF THE PRINCIPAL
EXPORTERS AND INSTITUTIONS

By

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Abstract

This study sought to determine the feasibility of introducing bamboo as a raw material to supplement the dwindling stock of traditional timber species for Ghana's forest products industry. First, the CEOs of the leading exporters of tertiary and panel products in the industry were canvassed to assess the current situation. Using descriptive statistics, it was discovered that the companies studied consume logs 12% in excess of the annual allowable timber harvest for the whole industry. There has been a drop in raw material availability and a 30% increase in raw material costs in the past five years. Harvest of lesser-used species in place of traditional species has also increased. Smaller companies have lost customers and are more restrained in raw material procurement.

Next, barriers to the adoption of bamboo as a raw material perceived by the CEOs and institutional heads were identified. The major barriers perceived by CEOs include lack of information (e.g., on bamboo plantation management, products, processing, machines and markets) and lack of capital for investment. Institutions lack adequate information about bamboo technology and policy; they have research needs, (e.g., training, funding, laboratory equipment) and collaboration from all stakeholders. Institutions have done little to promote bamboo.

Smaller companies were found to be more innovative in product development than larger companies. Companies located in the Ashanti region show higher propensity to engage in process innovation and product development. Companies appear to be receptive to initiatives that encourage bamboo adoption. In the current situation, few companies are willing to adopt bamboo but most companies are ready to adopt in the future if the existing barriers are mitigated.

In the current situation, it is difficult for the industry to adopt bamboo until the government officially specifies roles for institutions and other stakeholders to make a compelling case for bamboo. Suggestions made for policymaking and change management include strategies for the creation of awareness, desire and knowledge for bamboo. Others include providing resources to enhance the ability of companies and institutions to adopt or promote bamboo, and reinforcing the change from timber to bamboo.

Dedication

This work is dedicated to my family who have continually supported me and shown their love in various ways.

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CHAPTER 1: OVERVIEW OF THE STUDY-GHANA'S FOREST PRODUCTS INDUSTRY

Introduction

Ghana's forest products industry plays a very important role in the country's economy. Ranking third in export value, its exports trail only those of gold and cocoa. The sector contributes about 6% of the country's GDP; 11% of foreign exchange earnings and 30% of export earnings (Bank of Ghana, 2004). Ghana's major export trade goods as reported by the Department for International Development (DFID) and others include agricultural products, timber and mineral resources (mostly gold) (DFID, 2003; FAOSTAT, 2005; World Bank, 2005; 2006a; Ghana Homepage, 2006). Forest products Free on Board (FOB) export value was second to only cocoa in 2004 and 2005 (World Bank, 2006b; Bank of Ghana, 2004). Agriculture (including fisheries and forestry), accounts for 56% of the country's total workforce of 11.1 million (Bureau of African Affairs, 2006). The wood industry provides direct employment and livelihood to several people throughout the country (Bank of Ghana, 2004).

The Ghana Forestry Commission (GFC), the lead institution focused on the forestry sector, and recent research projects report that the wood industry currently faces acute raw material shortages due to illegal logging and other anthropogenic activities (GFC, 2006; Eastin, 2003; Bank of Ghana 2004). In addition, other constraints impact the industry's success. For example, Eastin (2003) developed an assessment framework for marketing lesser-used species in Ghana. He found in his interviews with managing directors and general managers that lack of technical information on the species, lack of information on the end uses of the species and inadequate information on the machining of the species are the barriers to the adoption of new technologies (Eastin, 2003). We need to test this further.

To ensure the survival of the industry, the supply of adequate wood raw material cannot be overemphasized (Ayres, 2001; Bretschger and Egli, 2001). As the primary raw material base can no longer adequately supply the industry, the adoption of lesser-used or plantation grown species might be helpful (Tomaselli, 2007; Upton and Attah, 2003; Donkor, Vlosky and Attah, 2005). This work seeks to determine the feasibility of introducing bamboo, a plantation species, to supplement timber in Ghana's forest products industry. To begin, the current situation (the forest resource base, raw material availability, quality of raw materials and markets) needs to be determined including the impacts of raw material decline on the industry. This will help in knowing the magnitude of the intervention that may be needed. Once that is completed, the barriers and needs perceived by the industry's CEOs and institutional heads in the process of adopting bamboo to supplement timber will be determined.

Statement of the Problem

The annual allowable cut¹ (AAC) of timber in Ghana's forests is one million m³. Nevertheless, some species such as Odum, i.e., Iroko (*Milicia excelsa*), Afrormosia (*Pericopsis elata*) and Sapele (*Entandrophragma cylindricum*), have been harvested excessively and classified as threatened species (Oldfield, Lusty and MacKinven, 1998; Ofori et al., 2003; Upton and Attah, 2003). The installed capacity (total volume of logs the industry can consume) of the domestic wood products industry is 5.7 million m³ per annum; a capacity that exceeds the AAC. Hence companies have to buy illegally harvested logs to adequately feed their mills (Bank of Ghana, 2004). The Food and Agriculture Organization of the UN (FAO) estimated that Ghana's annual deforestation rate is around 120,000 hectares (FAO, 2003) although slash and burn and

¹ The legal maximum volume of logs that can be extracted per year from the forest; determined through stock and pre-felling surveys by technical officers of the Forestry Department of Ghana.

fuel wood collection account for a preponderance of this amount (Eastin, 2003). Deforestation in Ghana is also attributed to mining and quarrying.

The decline of Ghana's forest area has attracted the attention of government, research organizations and educational institutions. To reduce pressure on primary timber species, the government has encouraged the harvest of lesser-used species (Upton and Attah, 2003; Donkor, Vlosky and Attah, 2005) but this is not a sustainable solution to halting deforestation. The Ghana Forestry Commission (GFC) reports that the volume and value of the country's wood product exports prior to 2004 were decreasing at 6% and 10% respectively. This was due to the diminishing trend in raw material availability, and the excessive dependence on commodity products (GFC, 2006). The sale of plantation Teak by the Ghana Forestry Commission to the industry reversed the trend. Teak has gained great importance in India and became Ghana's third most important lumber export species in 2005 (GFC, 2006).

It has been suggested that poor soils could support plantation species (Odoom, 2002). Forest plantations in tropical countries are seen as a good alternative to supporting timber from natural forests because they are cost-effective, potential substitutes for wood and reliable sources of raw material (Tomaselli, 2007). According to the Ghana Forestry Commission, 184 businesses are qualified to bid for government timber through the Timber Utilization Contracts² (TUC) for raw material (GFC, 2004). However, not all these companies are able to bid for raw material. Several mills have shut down or have been forced to engage in downstream processing due to raw material scarcity and the stringent TUC log acquisition laws introduced by the government in the late 1990s. **Figure 1.1** is a closed company identified while conducting the field work for

² TUC is the mode in which timber companies bid for timber concessions. The highest bidders win. It could be difficult for firms with inadequate resources to compete for this supply of raw material.

this study. The industry is also currently facing fierce competition from the Far East (GFC, 2006).



Figure 1.1: Equipment Lays Idle at a Mill that Closed due to Shortage of Timber Raw Material

The decline in raw material supply and the inability of native lesser-used timber species to adequately supplement traditional timber species is not sustainable. This study seeks to determine the feasibility of using an alternative natural fiber material to supplement dwindling timber supplies. One potential new fiber which may fill this gap is bamboo. Bamboo is cheap and grows fast (Ruiz-Perez et al., 2001; Hiziroglu et al., 2005). The utilization of bamboo in Ghana to supplement timber supply by the forest products industry could be an innovation and a potential antidote to the alarming rate of deforestation.

Oteng-Amoako, et al. (2004) conducted a countrywide study on bamboo to collect general information (e.g., species, anatomy, dealers, harvesting and products) and observed barriers to bamboo utilization. For example, their study revealed that the natural stands of bamboo are diminishing, and this may necessitate bamboo plantation establishment for increased

bamboo commercialization to succeed. The authors also discovered other barriers, e.g., harvesting problems, lack of efficient equipment for small-scale processors and lack of promotional materials. In a recent press conference, a managing director for one of the few commercial bamboo processors urged the Ghana government to promote research that would identify merchantable bamboo species and promote markets for bamboo and bamboo products (Ghana Business News, 2006).

These research outcomes and the press report reveal major barriers that have to be removed before the wood industry can use bamboo on a commercial scale. Consequently, it is important to identify the barriers and needs perceived by managing directors/general managers of the principal exporting companies of tertiary and panel products in Ghana's wood industry. The affiliated policy makers and industry associations also need to be investigated to determine the feasibility of introducing bamboo in the industry. More information is needed on bamboo plantation management, processing, marketing and utilization, and intellectual capital to get mills to adopt bamboo as a raw material. Before suggesting long-term solutions, Ghana's forests and the forest products industry are examined in more detail.

Literature Review

A review of literature will develop concepts that help in meeting the objectives of the study. The review focuses on Ghana's forest resource base and production and marketing trends in wood products in the industry. It is important to assess the presence and importance of bamboo in Ghana, current research and development of bamboo products, and market trends for bamboo products.

Ghana's Forest Resource Base

Ghana has a total of 1.8 million hectares of forests in government owned reserves and 3.7 million hectares of forestland outside reserves (Upton and Attah, 2003). The land cover is divided into three ecological zones; the savanna³ zone, the high forest⁴ zone and the transition⁵ zone (Odoom, 2002; ITTO, 2006a) as shown in **Figure 1.2**. With a land area of 23.9 million hectares, Ghana boasts of a corresponding 8.1 million (34%) hectares of the high forest zone in the south, 14.7 million (61%) hectares of the savanna zone and 1.1 million (5%) hectares of the transition zone (ITTO, 2005).

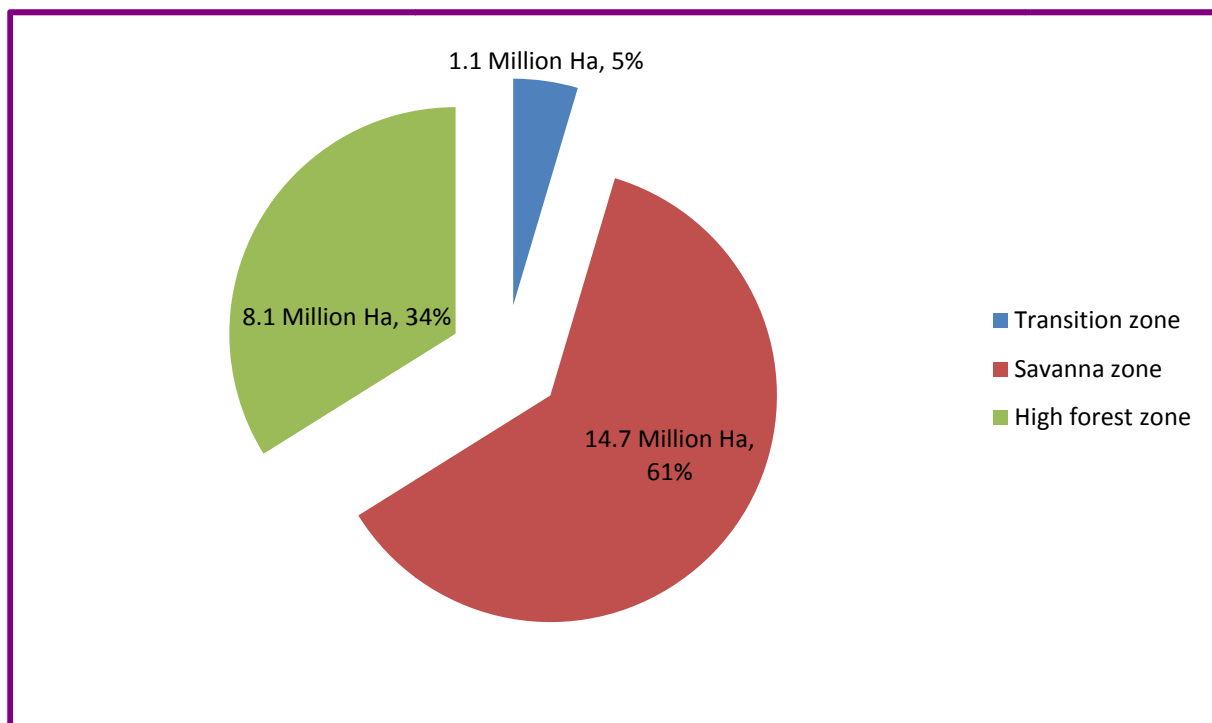


Figure 1.2: Ghana's Land Cover (Ha)

Data source: ITTO, 2006a.

³ Lacks adequate wood for all purposes

⁴ Has rich species diversity for local needs and timber

⁵ Boundary between the savanna and high forest zones

There are 266 forest reserves, 204 of which are in the high forest zone and 62 in the savanna zone. The total area of forest reserve is 1.76 million hectares, 1.634 million hectares of which fall under the jurisdiction of the Forestry Department which is overseen by the Ghana Forestry Commission (GFC).

Most of the country's commercially harvested timber is located in this area (Kasanga, 2002; Odoom, 2002; Fineman, 2004; ITTO 2006a). The remaining 126,000 hectares are managed by the Wildlife Division of the Forestry Commission as national parks. Commercial scale harvest of timber can also be harvested from an estimated off-reserve area of 400,000 hectares (Kasanga, 2002). Three types of forest exist in the country; rain forest i.e. 47% forestland, tropical forest (32%) and dry tropical forest (21%). These are comprised of the following specific vegetation types; low grass savanna, savanna woodland, wet and moist deciduous forest, evergreen forest, coastal savanna and mangrove swamp (ITTO, 2006a).

The deciduous and evergreen forest in the southwest is the main source timber. *Triplochiton scleroxylon* (Wawa), *Mansonia altissima* (Mansonia), *Nesogordonia papaverifera* (Danta) and *Kyaya ivonrensis* (Mahogany) are the predominant species inhabited in the deciduous forests. The predominant species in the evergreen forests are *Guarea cedrata* (Guarea), *Tieghemella heckelii* (Makore), *Tarrietia utilis* (Niangon) and *Uapaca spp* (Assam) (ITTO, 2006a). These species are important to the industry because of their timber quality and desirability to foreign buyers.

Administration of the Forestry Sector

Ghana's first official forest policy in 1947 was revised in conjunction with the 1992 constitution, and the revised policy approved in 1994 as the Forest and Wildlife Policy (ITTO,

2005). The policy dictates the management of the permanent forest estates (PFE)⁶ for soil, water and biodiversity conservation and development of productive and efficient forest-based industries. It also supports outreach programs and the involvement of rural communities in forestry and wildlife conservation, research-based and technology oriented forestry and wildlife management, and capacity development in sustainable forest management (ITTO, 2005). **Figure 1.3** shows the coverage for productive natural, planted and protected forests. As shown, 72% of the country's forest is natural.

Twenty two percent is protected and 6% is planted. The planted area has been growing in recent years. The discussion on the forest products industry comes next.

Production Trends in the Forest Products Industry

For many years, Ghana's forest products sector has been supplied by domestic sources. **Table 1.1** shows the total volume of round industrial wood and firewood produced in 2000-2004. The yearly estimated volume of wood consumed for firewood and charcoal was 20.678 million m³ for 2000-2004 (FAO, 2006).

⁶ Public or private land kept under permanent forest cover as (i) protection forests on fragile lands (ii) forests preserved for plant, animal or ecosystem conservation or (iii) production forests (ITTO, 2005).

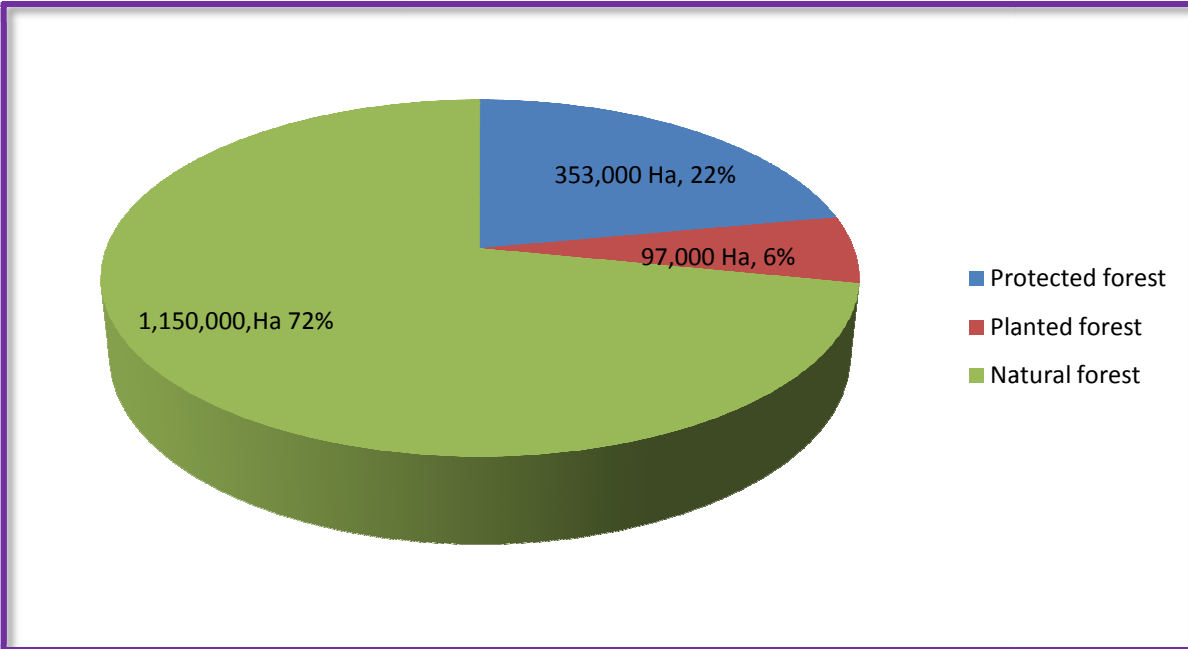


Figure 1.3: Production and Protection Forest Coverage (Ha)
Data source: ITTO, 2006a.

The volume of round wood consumed for fuel wood and charcoal is about 15 times more than that consumed for industrial purposes. This suggests that the largest cause of deforestation is fuel wood and charcoal production. From 2000, industrial round wood production increased and then dropped slightly in 2002 and then in 2004. It is generally an increasing trend which far surpasses the annual allowable cut (AAC) of timber (i.e., 1,000,000 m³).

Table 1.1: Ghana's Round Wood, Industrial and Fuel Wood Production (1,000 m³)/Year

Volume	2000	2001	2002	2003	2004
Wood fuel and charcoal	20,678	20,678	20,678	20,678	20,678
Industrial round wood	998	1,212	1,104	1,400	1,350
Total round wood	21,676	21,890	21,782	22,078	22,028

Data source: FAO, 2006.

The Ghana Forestry Commission categorizes the country's timber industry into three operational groups; the primary (logging) sector, the secondary (sawmilling, panel product manufacturing) sector and the tertiary (including furniture, furniture parts, moldings, flooring, profiling, and doweling) sector (GFC, 2007). **Table 1.2** provides a summary on the distribution of the production sectors of the forest products industry during the years 1991-2001. The number of sawmills nearly doubled while veneer and plywood mills increased markedly. The profits in downstream processing led to a rapid increase in molding and flooring mills. However, the number of furniture companies has remained at 40 since 1991 (Bank of Ghana, 2004).

About 20 companies account for 90% of exports and 66% of value while approximately 160 small and medium sized companies account for 34% of export value (Bank of Ghana, 2004). The total number of exporters is not well known.

Table 1.2: Major Production Sectors of Ghana's Wood Industry (1991-2001)

Activity Area	Number of Firms			
	1991	1994	1998	2001
Primary (Logging)	200	250	250	250
Secondary				
Sawmilling	100	110	140	194
Veneer milling	13	15	25	32
Plymilling	9	9	14	14
Tertiary (Lownstream)				
Furniture	40	40	40	40
Flooring	4	6	6	14
Particleboard	1	1	2	2
Doors	4	6	6	2
Toys	2	4	4	6
Profile boards/Moldings	5	12	22	47

NB: Firms may be involved in more than one activity area.

* Sawmill units do not include estimated 39 mills situated within the forest.

Source: Bank of Ghana, 2004.

For instance, GFC (2004) reported that more than 200 (not specific with the actual number) companies exported lumber in 2003. The same source contends that a total of 184 businesses are qualified to bid for Timber Utilization Contracts (TUC) forest harvest concessions that furnish companies with timber raw material (GFC, 2004). The directory for the Association of Ghana Industries (AGI) lists 90 wood product manufacturing member companies (AGI, 2006). Yet in 2000, there were 159 lumber exporters (GFC, 2004). For decades, Ghana had exported massive amounts of logs which hastened the pace of the forest resource loss. The government instituted a log export ban in 1995 and this compelled companies to develop secondary and tertiary products (Bank of Ghana, 2004).

The average production volume (domestic and export) of Ghana’s wood products in the period 2000-2004 as reported by the Forestry Commission was 56% sawn wood, 31% veneer sheets, 12% plywood and 1% particleboard (see **Figure 1.4**).

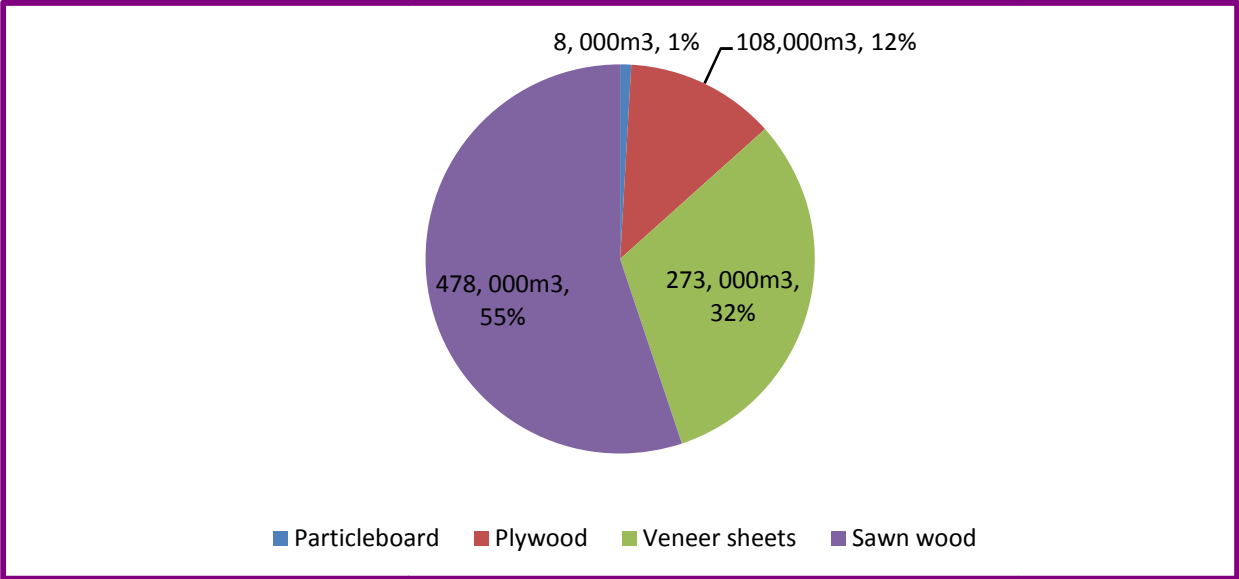


Figure 1.4: Average Production Volumes of Ghana’s Forest Products (2000-2004).
Data source: FAO Yearbook, 2006.

Figure 1.5 shows the volumes of the products that served domestic purposes and those exported for the period 2000-2004.

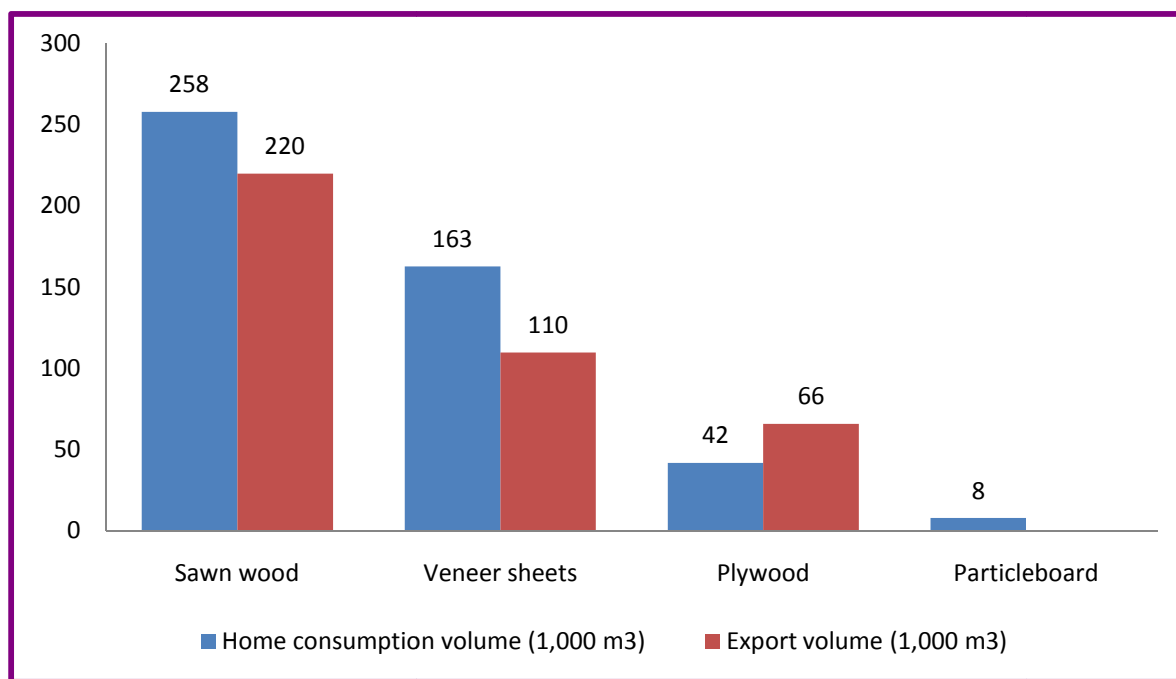


Figure 1.5: Average Domestic Consumption and Export Volumes (1,000) m3 for 2000-2004
Data source: FAO, 2006.

Apart from plywood whose export volume was higher than that consumed locally, all other products were used much more locally than were exported (GFC, 2006). With the production trends now known, it is important to determine the market opportunities that exist for these products. In the next section, the forest product market trends are discussed.

Export Markets in the Forest Products Industry

The Ghana Forestry Commission reports a total export value of US\$202 million in 2003 (GFC, 2004). In 2005, all exports amounted to 466,155m³ with a corresponding value of US\$220.8 million (GFC, 2006). **Figure 1.6** shows the average volume and value for sawn wood,

veneer and plywood for 2002-2006. Veneer with an average volume of 100,400m³ had a value of \$56,415,800 which appears to have the highest price to volume ratio followed by sawn wood and then plywood.

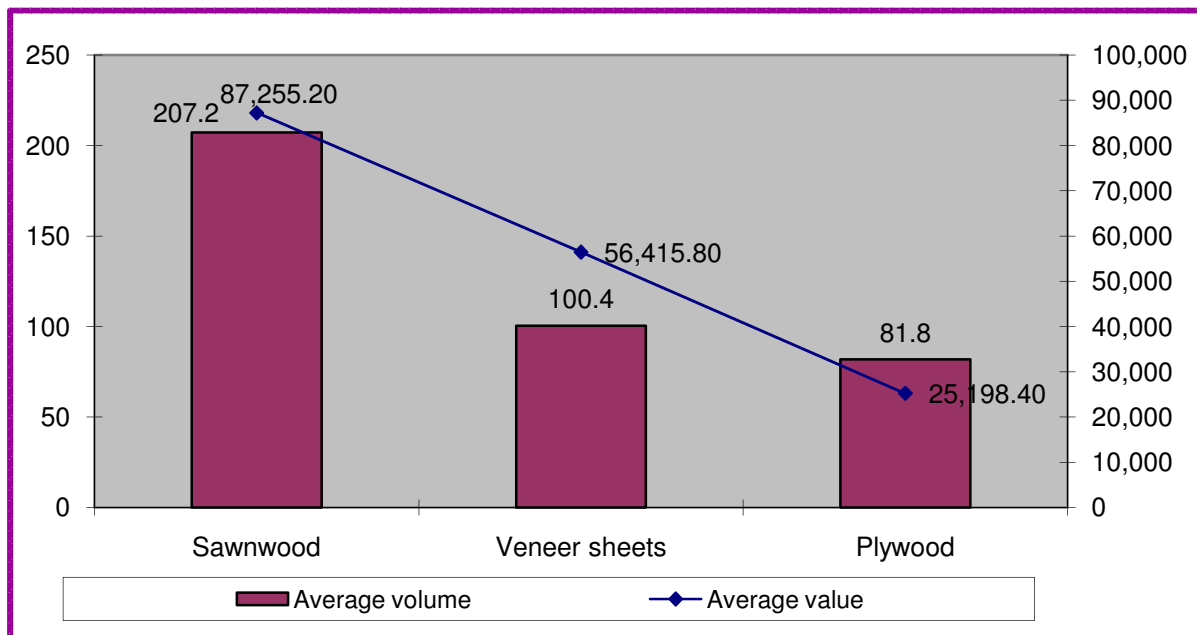


Figure 1.6: Average Volume (1,000m³) and Value (1,000\$) for Ghana's Wood Products (2002-2006). Data source: FAO Yearbook, 2008.

Western Europe is the primary importer of Ghana's wood products including Spain, Italy, The Netherlands, France, Belgium, Germany and the UK. Other important importers include the U.S., India and Nigeria (GFC, 2004; GFC, 2006; ITTO, 2006b). In 2004 the EU accounted for 56% value and 53% volume of Ghana's exports (ITTO, 2005). New markets identified by the industry include India, Nigeria, and the Middle East (GFC, 2006; ITTO, 2006b).

The export trade is segmented into lumber, panel and machined products. In 2004, the export volume was 50% for lumber and boules (air/kiln dried), 39% for panels (plywood, chipboard and veneers) and 11% for machined products (furniture parts, moldings, parquet flooring, etc.), (GFC, 2006). About 48% of the sawn wood, 40% of veneer sheets and 60% of the

plywood produced in 2000-2004 were exported. All the particle board produced was consumed domestically (GFC, 2006).

The export volumes of air and kiln dried lumber and flooring increased in 2005. Air dried volume of lumber, for example, increased from 95,000m³ in 2004 to 125,000m³ in 2005. The volume of exports of rotary veneer, plywood, machined products and furniture parts declined in 2005. The volume export of sliced veneer for both 2004 and 2005 remained the same at about 40,000m³ but showed a slight drop in value in 2005. The value for kiln and air dried lumber correspondingly went up in 2005. Despite a drop in volume of about 4,000m³ in 2005, rotary veneer exports increased in value from about 30,000,000 Euros in 2004 to about 32,000,000 Euros in 2005 (GFC, 2006). Flooring performed better in volume in 2005 but quite poorly in value. Furniture parts showed a net increase in value in 2005 (GFC, 2006).

Italy and France were the main consumers of Ghana's floorings in 2003 and 2004. Although the export volume to Italy decreased from 2003 to 2004 there was a corresponding increase in value. The main species were odum/iroko (a premiere but scarce species) and papao (a lesser-used species) whose expanded use is being encouraged. There is an interesting observation here in the selection of species. Odum/Iroko, one of the species whose depletion led to the adoption of lesser-used species and other alternative fiber sources, dropped in volume from 503m³ in the first quarter of 2003 to 324m³ in 2004 and was replaced with papao (a lesser-used species) with even a higher value per volume. Some of the other lesser-used species are Essa, Yaya and Mansonia. The industry began to process a larger number of lesser-used species in 2004. This led to a higher flooring volume being produced (GFC, 2006).

The U.S. and Belgium were the biggest importers of Ghana's plywood in 2003-2004. Other destinations included Italy, The Netherlands, France, Australia, Greece, Senegal,

Germany, UK, Angola, Spain, Denmark, The Gambia, Sierra Leone, Equatorial Guinea, Nigeria, Morocco and China (GFC, 2006). The UK is a major consumer of Ghana's furniture parts. Odum (Iroko) and Mahogany are the main export species for furniture parts. Other species used for furniture include Albizia and Akasa and planted Teak. There is evidence that Odum is still positioned well in the marketplace. However, there is also a trend that shows gradual introduction of lesser-used species to supplement supply of the premiere species (GFC, 2004). The U.S. leads the world in rotary veneer imports from Ghana. Rotary veneer species include Ceiba, Otie, Essa, Kyere, Chenchen and Ogea (GFC, 2004). All the markets identified in this review are important to Ghana's forest products industry. In introducing alternative raw materials in the industry, these markets need to be explored. In the next section, a literature review is presented on bamboo.

The Presence and Importance of Bamboo in Ghana

Bamboo is the tallest and fastest growing grass species (Weber, 2002) with some species growing one meter per day during the growing season (Hiziroglu et al., 2005). As an added advantage, bamboo regenerates naturally after the first planting (Suttell, 2004). The most common native bamboo species in Ghana, *Bambusa vulgaris*, matures in four to six years and is found in almost all the forest vegetation zones in the country (Oteng-Amoako et al., 2004). The species has many uses including fencing, roofing and garden furniture. Several research and development programs have investigated the commercial use of bamboo as shown next.

Research and Development of Bamboo Products

Bamboo has been used traditionally for building houses in Latin America, and efforts are being made now to improve product designs to encourage its increased use (Paudel and Moran,

2004). Furniture from plywood made of bamboo and wood with the natural striped design and yellow color have been developed in Ecuador (Brito and Cevallos, 2004). A study in Thailand that focused on five bamboo species has revealed that, depending on the size, length and thickness of culms all the five species can be used for construction (Thaipetch, 2004). Recently in Ghana, bamboo has become an important raw material in the flooring and paneling industry. The current uses include floorings, ceiling panels, window blinds, doors, furniture, and artifacts. However, the dire need for quality improvement and commercial expansion cannot be overemphasized (Ghana Govt., 2004; Oteng-Amoako et al., 2004).

In India, bamboo mat board (BMB) and bamboo mat veneer composite (BMVC) have been developed as alternatives to plywood. Bamboo mat corrugated sheets (BMCS) are also being developed to substitute corrugated roofing made from metals or asbestos (Pandey, 2005). Naidu et al. (2005) found BMCS to be light weight, strong and having thermal insulating qualities exceeding construction materials. They also found BMCS to be resistant to water, fire, decay, and insect attack (Naidu et al., 2005). Bamboo has good strength properties (Sumardi et al., 2006; Hershey, 2004). In a recent test at the Central Power Institute of India at Bangalore, a full-scale bamboo building fixed to the shake table was found to withstand a series of earthquake simulations and showed no sign of structural rupture (Brown, 2004). The attributes of bamboo make it a superb non-timber material that can substitute for wood (Sumardi et al., 2006; Hizioglu et al., 2005; Ruiz-Perez et al., 2001). Research and development in bamboo manufacturing has necessitated a search for markets.

Markets for Bamboo Products

There is growing interest in a variety of bamboo flooring products (Weber, 2002). IKEA, the popular international furniture company, has been one of the leading buyers of laminated

bamboo flooring from Asia (Cohen, 2003). Bamboo is desirable in making flooring because of its beautiful stripes and nice color (Weber, 2002) and has higher impact strength than most floorings made from wood ⁷(Sumardi et al., 2006). As mentioned previously, bamboo has been described as one of the best materials of modern high-tech fiber innovations being used in the bath towel industry. High quality towels made from a blend of bamboo, silk and cotton are catching a higher market share in the top bath and towel importing companies in the United States (Corral, 2005). For example, the famous clothing company, Tommy Hilfiger Inc., has introduced a new fiber mix of bamboo and cotton towels, which have been priced higher than existing products (Home Textiles Today, 2005). Some textile companies in other countries such as Italy and Japan are also increasingly buying bamboo fiber from China (Borland, 2004).

With an annual production of 8.5 million tons of bamboo products and an output value of US\$4.5 billion, China leads in the bamboo products market, exporting approximately US\$600 million worth of bamboo products annually (Global Wood, 2005). Prices of bamboo products match those of mid-range hardwoods such as oak, with “Bamstar” planks having premiums of about US\$4-6/ft² in 1/2-5/8 inch thickness, 3^{5/8} inch widths, and 3 or 6 ft lengths (Weber, 2002). The increased use of bamboo in China over the past years has resulted from the implementation of various policy instruments that address important issues such as management, environmental safety (e.g. threshold values for fertilizers, herbicides etc.), training, trade and small enterprise development (Ruiz-Perez, et. al., 2001).

Justification

Looking at the necessary inputs of the study, it is reasonable to justify why this study is important. This study is justified as (1) there are existing raw material constraints in Ghana’s

⁷ Personal communication with Dr. Oteng – Amoako, FORIG, Ghana. August, 2006.

forest products industry, (2) plantation bamboo utilization in Ghana may supplement timber, (3) there is potential for expansion of bamboo commercialization, (4) the Ghana government and FORIG support bamboo utilization and (5) there is evidence of potential markets for bamboo products. These factors are further explored below.

Constraints in Ghana's Forest Products Industry

Ghana's forest products industry currently faces several problems. As indicated earlier, the raw material base is declining quickly (GFC, 2006). Lack of technical information on the use of lesser-known species and their end uses, and inadequate machining information are major barriers to the adoption of lesser-used species. Other constraints that afflict the industry include lack of efficient equipment, rising internal costs, need for skillful personnel and costly loan acquisition procedures in the Ghana banking system (GFC, 2004).

Due to the stricter means of raw material procurement, and the barriers that have been identified in some studies, it is imperative to conduct this study to identify other barriers to the adoption of bamboo in the industry. The study will help identify existing barriers and indicate potential interventions that can promote increased adoption of bamboo. This would save the remaining natural forest while providing a sustainable flow of raw materials.

Need for Bamboo Utilization in Ghana

Bamboo can be used for various products in the same fashion as wood, and therefore, comes under serious consideration as a useful planted raw material to supplement timber. To ensure this, one should identify possible avenues for increased utilization of the product in Ghana. As there is inadequate literature and virtually no primary data on bamboo utilization in Ghana, this study could be a potential source of useful information for the country.

Need for Commercial Expansion of Bamboo Utilization

Bamboo is used in Ghana for many purposes and products such as fencing, roofing, garden furniture and flooring. The standing volume of bamboo in certain parts of the country is, however, underutilized and could be used to supply other parts of the country's forest products sector. The local and export use of bamboo will encourage efficient utilization of the natural and plantation stands. Research and development in bamboo has grown over the years. Bamboo products have become commercialized too. However, Ghana has not adopted bamboo on a commercial scale. This may be possible with support from the government.

Support from Ghana Government and Research Institutions

The literature review indicated that the government of Ghana is currently advocating bamboo utilization as an alternative fiber source (Ghana Govt., 2004; GFC, 2007). The objectives of this study have been developed in agreement with the Forestry Research Institute of Ghana (FORIG), which seeks to ensure sustainable development and improved utilization of bamboo in Ghana. The study could contribute to the efforts being made by the government of Ghana and the International Network for Bamboo and Rattan (INBAR) to encourage the commercial utilization of bamboo. The government is promoting establishment of plantations with the help of INBAR and FORIG. The government and FORIG are also developing modalities for further research into product development, policy formulation and marketing. Government support in promoting bamboo must be accompanied by other factors such as accessible markets to ensure fruition in the efforts to use bamboo. The next topic justifies the market potential for bamboo products.

Market Demand for Bamboo Products

It is evident from the literature review that the number of innovative uses of bamboo is growing. The prices of bamboo products can compete with those of some wood products. Asia leads in global trade in bamboo products. Informal survey of retail furniture stores in New York City also provides some evidence about market existence for bamboo products. With the current promising market trend, bamboo processing and marketing in Ghana looks laudable. Thus, the objectives of this study have been set as follows.

Goal and Objectives

As the literature review and justification for the study have shown, bamboo has been used successfully by other countries. The goal of this research is to determine the factors that may impact the adoption of bamboo as alternative and supplemental raw material to timber in Ghana's tertiary (including furniture, molding, floorings) and panel (plywood and chipboard) sectors of the forest products industry. The study seeks to meet the following objectives:

- (i) To create a profile (scope, size, markets, products, etc.) of Ghana's forest products industry and determine the impact of forest resource decline on the industry.
- (ii) To identify barriers (e.g. quality, capital, cost, cognition, marketing, management, equipment, etc.) to the adoption of bamboo as a raw material in the tertiary and panel sectors of the wood industry as perceived by managing directors and general managers.
- (iii) To identify barriers (e.g. research, logistics, cost, cognition, personnel, etc.) as perceived by policymakers and industry associations that may affect their ability to influence increased adoption of bamboo as a raw material in the sectors of concern.

(iv) To develop policy instruments and change management models to assist government, industry, policymakers and industry associations in implementing the change.

In meeting these objectives, the dissertation is organized in the following fashion. Chapter 1 presents the statement of the problem, relevant literature review, the justification for the study and objectives. Chapter 2 contains the theoretical foundation for the study. It draws on the relevant literature in diffusion of innovations to make a case for bamboo as a useful alternative to timber. A second theoretical foundation, the Natural Capital Strong Sustainability Theory, is used to explain the holistic benefits to communities if bamboo is planted and used for processing in Ghana's forest products industry. Chapter 3 determines the current situation and the impact of natural timber raw material decline on Ghana's forest products industry. Chapter 4 focuses on the barriers and needs perceived by the managing directors of companies in the adoption of bamboo as a new fiber material. Chapter 5 seeks to determine the barriers and needs perceived by institutions/policymakers and industry associations in their bid to promote the adoption of bamboo in Ghana's forest products industry. Chapter 6 uses the results from the study in conjunction with Hiatt's model of change to develop change management and policy models for the successful implementation of the bamboo adoption initiative. The study ends with the conclusions presented in Chapter 7.

Conclusions

Ghana's forest products industry is faced with increasing decline in raw material. Scarce species e.g. *Milicia excelsa* (Odum) are still under pressure. The annual allowable cut of timber, i.e. one million cubic meters, is high and the natural forests may not be capable of sustaining this level of supply for future processing. There has been evidence of the adoption of lesser-used

species to supplement premiere timber species. There is evidence also about the use of plantation species to supplement the natural standing timber. The adoption of lesser-used species and timber plantation species is one way to meet industry needs for raw material. However, this adoption could still provide insufficient supply.

Another fast growing species that could be adopted as an alternative fiber supplement to wood is bamboo. Bamboo matures within 3-8 years if managed well and regenerates naturally after the first planting. It has good mechanical and quality properties that compare well with wood. Its product profile and market potential are expanding, and products such as floorings, furniture parts and panel products are easily manufactured from it and sellable at competitive prices. *Milicia excelsa* (Odum i.e. Iroko), a Ghanaian premiere species compares very well with bamboo in its nice yellow color and should be easily substitutable with bamboo. It can also be deduced from the previous discussion that e.g., (see **Figure 1.4**) plywood and particleboard constitute about 11% of Ghana's exports. This plus the 11% of machined products (i.e. floorings, furniture parts etc.) that make up all export volumes yield a total of about 22% for which bamboo can be used as a raw material. With the help of the Ghana government and the International Network for Bamboo and Rattan (INBAR), plantation bamboo could be adopted to supplement the dwindling natural forest resource base. Considering the problems, there is the need to undertake this study to see if the concept is feasible.

Literature Cited

Association of Ghana Industries (AGI). 2007. Member List – Wood Sector
<http://www.agighana.org/directory/14.htm> Last visited, 01/01/2007

Ayres, R. U. 2001. The Need for A Growth New Paradigm, In: Cleveland, C., D. I. Stern, and R. Costanza. (Eds.), The Economics of Nature and the Nature of Economics. Edward Elgar Publishing, Northampton, MA, USA. 293pp.

Bank of Ghana. 2004. Report on the Timber Industry in Ghana. Research Department, Sector Study Series. 1(1): 1-33.

Borland, V. 2004. Technology & Novelty at Premiere Vision. Textile World, Atlanta. 154(5): 52-55.

Bretschger, L. and H. Egli. 2001. Sustainable Growth in Open Economies, In: Schulze, G. G. and H. W. Ursprung. (Eds.), International Environmental Economics: A Survey of the Issues. Oxford University Press Inc., New York. 301pp.

Brito, C. and D. Cevallos. 2004. New Bamboo Furniture. INBAR News. 11(2): 1.

Brown, J. 2004. Bamboo House Passes Seismic Test. Civil Engineering, New York. 174(11): 27.

Bureau of African Affairs. 2006. Background Note: Ghana. U.S. Department of State. <http://www.state.gov/r/pa/ei/bgn/2860.htm> Last visited, 05/15/07.

Cohen, M. 2003. IKEA Bets on Vietnam. Far Eastern Economic Review, Hong-Kong. 166(38): 56.

Corral, C. B. 2005. Product Innovations Drive Strong Bath Market. Home Textiles Today, High Point. 26(29): 12.

Department for International Development (DFID). 2003. Ghana: Country Assistance Plan 2003-2006. 23pp.

Donkor, B. N., R. P. Vlosky and A. Attah. 2005. Appraisal of Government Interventions for Diversification of Species Utilization in Forest Product Exporters: Lessons from Ghana. Journal of the Institute of Wood Science. 17(1): 1-10.

Eastin, I. L. 2003. Toward the more Effective Marketing of Lesser-Used Tropical Timber Species: A Theoretical Framework. Ghana Journal of Forestry. 11(2): 1-13.

FAO (Food and Agriculture Organization of the United Nations). 2003. Annual Yearbook of Forest Products - 2002. Forestry Department, Rome. 228pp.

FAOSTAT. 2005. Ghana: Economic Situation - Food and Agriculture Indicators. www.fao.org Last visited, 05/16/2007.

FAO Yearbook. 2008. Forest Products (2002-2006). FAO, Rome. 243pp.

Fineman, S. 2004. Timber from Well-Managed Forests: Part 2. Journal of the Institute of Wood Science. 16(5): 252-257.

Ghana Business News. 2006. Businessman: Develop Bamboo as Alternative to Timber. Business News. <http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=98086> Last visited, 01/15/07.

Ghana Forestry Commission (GFC). 2007. The Timber Industry in Ghana <http://www.ghana-timber.demon.co.uk/> Last visited, 01/21/07.

Ghana Forestry Commission. 2006. A Newsletter about Ghana's Forests, Timber and Wildlife. Ghana Forestry Commission. Ghana Gazette. No. 38. First Quarter. 12pp.

Ghana Forestry Commission. 2004. A Newsletter about Ghana's Forests, Timber and Wildlife. Ghana Gazette. No. 32. June/July. 11pp.

Ghana Homepage. 2006. Ghana: Economic Indicators. www.ghanaweb.com Last visited, 05/17/07.

Ghana Government Homepage. 2004. Help Develop Bamboo as Alternative to Timber – Fobih. <http://www.ghana.gov.gh/investing/> Last visited, April 28, 2006.

Global Wood. 2004. Industry News and Markets: China Wood Products Prices. 16-30th October 2004.

Hershey, J. 2004. How to Build with Bamboo: 20 Projects you can do at Home. Library Journal, New York. 129(20): 158.

Hiziroglu, S., S. Jarusombuti, V. Fueangvivat, P. Bauchongkol, W. Soontonbura and T. Darapak. 2005. Properties of Bamboo-rice Straw-eucalyptus Composite Panels. Forest Products Journal. 55(12): 221-225.

Home Textiles Today. 2005. Tommy Mixes It Up. Special Report; Market Wrap. High Point. 26(32): 26.

ITTO (International Tropical Timber Organization). 2005. Tropical Timber Market Report. March, 2005. 26pp.

ITTO. 2006a. Status of Tropical Forest Management 2005. ITTO Technical Series No. 24, Japan. 302pp.

ITTO. 2006b. Tropical Timber Market Report. 11(20): 1-21.

Kasanga, K. 2002. Government of Ghana: Statement on the Sustainable Management of Ghana's Forests. Ministry for Lands and Forestry, Accra, Ghana. 4pp.

Naidu, M.V., A. Nandanwar and K. Shyamsndar. 2005. Evaluation of Properties of Bamboo Mat Corrugated Sheets (BMCS) for Roofing. Journal of the Indian Academy of Wood Science, Bangalore, India. 2(1): 76-89.

Odoom, F. 2002. Forest Plantations Working Papers: Hardwood Plantations in Ghana. Working Paper FP/24, FAO, Rome. 66pp.

Ofori, D. A., M. D. Swaine, J. R. Cobbinah and A. H. Price. 2003. Genetic Diversity and Biodiversity Conservation Guidelines for *Milicia* Species in Ghana. Ghana Journal of Forestry 11(2): 27-38.

Oldfield S., C. Lusty and A. MacKinven. 1998. The World List of Threatened Trees. World Conservation Press, Cambridge, UK. 650pp.

Oteng-Amoako, A. A., D. A. Ofori, L. C. N. Anglaaere, B. Obiri-Darko, and E. Ebanyenle. 2004. Sustainable Development of Bamboo Resources. Africa Forestry Research Network (AFORNET), Ghana Processing Report 1 (unpublished), (Jan-Dec. 2004). 13pp.

Pandey, C. N. 2005. Bamboo Products Technology Options. Journal of the Indian Academy of Wood Science, Bangalore, India. 2(1): 68-75.

Paudel, S. K. and J. U. Moran. 2004. Model Bamboo House in Guyaquil, Ecuador. INBAR News 11(2).

Ruiz-Perez, M., F. Maoyi, Y. Xiaosheng, and B. Belcher. 2001. Bamboo Forestry in China: Toward Environmentally Friendly Expansion. Journal of Forestry. 99(7): 14-20.

Sumardi, I., S. Suzuki and K. Ono. 2006. Some Important Properties of Strand Board Manufactured from Bamboo. Forest Products Journal. 56(6): 59-63.

Suttell, R. 2004. Going Natural. Buildings, Cedar Rapids. 98(10): 76-79.

Tomaselli, I. 2007. The Allure of Plantations. ITTO Tropical Forest Update. 17(1): 10-13. ITTO, Japan.

Upton, D. and A. Attah. 2003. Commercial Timbers of Ghana: Potential for Lesser-Used Species. Ghana Forestry Commission. 58pp.

Thaipetch, S. 2004. Physical and Mechanical Properties of Five Bamboo Species in Thailand, In: Final Technical Report – Project: PD 56/99 Rev. 1(1) – Promotion of the Utilization of Bamboo from Sustainable Sources in Thailand. International Tropical Timber Organization, Bangkok, Thailand.

Weber, C. 2002. New Bamboo. Builder, Washington. 25(7): 34.

World Bank. 2005. Data and Statistics. www.worldbank.org Last visited, 05/17/07.

World Bank. 2006a. Data and Statistics. www.worldbank.org Last visited, 05/20/07.

World Bank. 2006b. Ghana at a Glance. http://devdata.worldbank.org/AAG/gha_aag.pdf Last visited, May 3, 2007.

CHAPTER 2: THEORETICAL FOUNDATION

Introduction

The theoretical foundation for this research is based on Rogers' (2003) Theory of Diffusion of Innovations. Adoption of bamboo on a commercial scale in Ghana is a new concept. Several new activities have to be implemented to facilitate widespread adoption of bamboo as a new material. New manufacturing processes and products have to be developed, new marketing channels indentified and new skills acquired. Therefore, it is reasonable to conceptualize bamboo adoption in Ghana as an innovation under the theory of diffusion.

To establish an appropriate theoretical foundation for the study, literature is reviewed on diffusion of innovations, rate of adoption of innovations, perceived attributes of innovation, post-diction and prediction, and innovativeness. This helps to develop a conceptual model for the study. Examples and practical implications of some studies that used Rogers' theory of innovation are also discussed. Lastly, literature is reviewed on the Critical Natural Capital Sustainability Theory which may help support the use of bamboo as a substitute for timber raw materials.

Literature Review

Diffusion of Innovations

Diffusion of innovation is “the process in which an innovation is communicated through certain channels over time among the members of a social system” (Rogers, 2003, pg. 35). Unger (2005) asserts that it is diffusion of an innovation that eventually creates economic growth, not the innovation itself. Rogers (2003) defines innovation as “an idea, practice or object that is

perceived as new by an individual or other unit of adoption” (pg. 36). The innovation can take several forms, e.g. a new product, service, technology, administrative practice or research finding (Kuczmarski, 1996; Hage, 2005). Newness of an idea may be relative, i.e., a product is effectively new if it has lower costs, improved attributes and other new attributes that did not exist before. Further, if the new idea was used before, but now is used in a different application, it is an innovation (Afuah, 1998; Hill and Jones, 2004).

Whereas some individuals or social systems may see an idea as new, others may see it as already extant (Kotler et al., 1999). For example, in Ghana, the use of bamboo is not new but its plantation establishment, commercial use and novel product developments are new. The degree to which an innovation is new may be expressed in terms of knowledge, persuasion or a decision to adopt (Rogers, 2003). The whole innovation process can be viewed as a complex network of communication paths that link the various stages of the process (Ljungberg, 1982).

It is logical to ask: What triggers innovations? The first phase of the innovation development process is the identification of a problem or a need (Holbeche, 2006; Simpson, 1999). This need or problem triggers a search for a solution, resulting in research and development. Besides, scientists sometimes foresee imminent problems to which they may seek research solutions, preventing potentially negative consequences (Rogers, 2003; Simpson, 1999).

For example, at the University of California at Davis, one scientist foresaw a possible future need for labor at the end of the Mexican farm worker program, and developed an R&D program that opened the way for breeding hard tomato varieties, which could be mechanically harvested (Rogers, 2003). In a similar manner, given the fast pace at which Ghana’s natural forest resource base is diminishing, intervention and supply of fast growing species such as bamboo can be considered an innovation. Sedjo (1999) contends that innovation in the forest

products sector is inevitable. He asserts that plantation forestry (which includes fast growing bamboo stands) must become the wave of the future to circumvent the diminishing trend in natural timber raw material.

One indicator of the importance of plantation forestry is production quality control; plantations can be managed to improve growth rates, disease and pest resistance and fiber quality (Simpson, 1999; Sedjo, 1999). Before Ghana can realize the benefits of plantation forestry, however, the understanding of the plantation approach must diffuse through the networks of forestry practitioners.

The Innovation Development Process

Before an innovation, (e.g., adoption of planted bamboo as a substitute to timber) can achieve widespread adoption, it must first have been developed. There are six phases of the innovation development process. However, some innovations arise from serendipity and not directly from research and development (Hall, 2005; Rogers, 2003). The need identification stage of the innovation development process, the first stage, is followed by research & development – a systematic creative work that increases the stock of knowledge (Kahn, 2007; Schmoch, Rammer and Legler, 2006). Research and development is followed by commercialization - the process by which research & development results are transformed into the marketplace as usable products and services in a timely manner (Hill and Jones, 2004; Kozmetsky, 1991). This is followed by diffusion, adoption and consequences – the results after adoption (Carayannis et al., 1998; Rogers, 1971).

Specifically, Rogers' theory provides attributes that can be used in determining barriers to adoption. This theory is used in with the situation specific to Ghana to determine and circumvent the barriers that may impact the adoption of bamboo in Ghana's forest products

industry. The theory can be applied in the context of acceptability study to determine which barriers may need to be removed, or which needs should be filled to enhance bamboo adoption.

Rate of Adoption of Innovations

The “relative speed with which an innovation is adopted by members of a social system” is known as the rate of adoption (Rogers, 2003, pg. 23). This is measured by the time it takes for a certain proportion of the social system to adopt the innovation.

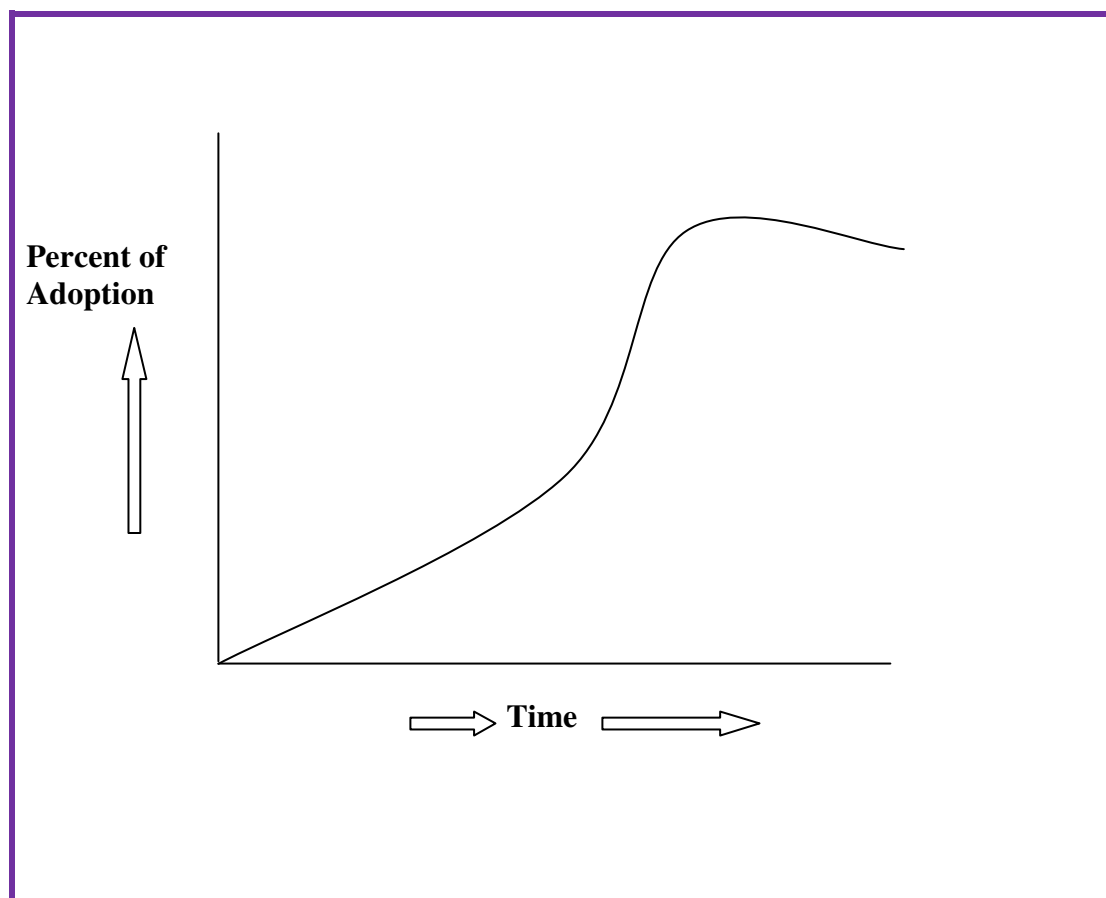


Figure 2.1: The Diffusion Process: Percent of Adoption versus Time
Source: Rogers, 2003.

Therefore, the innovation decision process, the innovativeness and adopter categories, and the rate of adoption are the time dimensions involved in the diffusion of innovations (Ryan, 1969). If the cumulative adoptive time path (temporal pattern) of an innovation is plotted, the

graph takes the form of an S-shaped (sigmoid) curve (Mahajan and Peterson, 1985; Hall, 2005; Rogers, 2003). Please see **Figure 2.1**.

We can interpret this phenomenon to mean that during the early stages of the innovation, only few individuals/social systems adopt. As time goes on and awareness knowledge increases, a relatively larger number of people adopt the innovation. At the final stage, the trajectory of the diffusion curve slows down and levels off at the upper asymptote, where the diffusion ends (Afuah, 1998; Hill and Jones, 2004; Kotler, et. al., 1999; Mahajan and Peterson, 1985; Rochlin, 2006).

Meanwhile, the rate of diffusion of innovations varies from one innovation to another. While some innovations take a very short time to diffuse, others take decades to diffuse. The diffusion curve maintains the same S- shape but may be steeper at the beginning if a relatively larger group of people adopts the innovation early or steeper at the top if a relatively larger group of people adopts the innovation late (Mahajan and Peterson, 1985; Rogers, 2003). This study aims at ensuring a relatively larger group of adopters in the beginning.

Many factors account for the rate at which innovations diffuse. One major component of such factors is the perceived attributes of innovations. A substantial part of an innovation's adoption rate variance (from 49-87%) can be traced to these perceived attributes of an innovation, i.e., relative advantage, compatibility, complexity, trialability and observability (Kotler et al., 1999; Rogers, 2003). Other variables that affect the rate of adoption include the kind of innovation decision, the nature of communication channels that permit the diffusion of the innovation at all stages of the innovation decision, the nature of the existing social system and the level of promotional work done by change agents (Ryan, 1969; Rogers, 1971). It takes a longer time for organizations than individuals to adopt an innovation.

This study uses the five perceived attributes of innovation to identify barriers that might impact Ghana's forest products industry in adopting bamboo. The attributes are explained below.

Perceived Attributes of Innovation

Rogers identifies five major attributes that affect the rate of adoption of innovations: relative advantage, compatibility, trialability, observability and complexity. Innovations, which individuals see as having higher relative advantage, compatibility, trialability and observability, and less complexity, have a higher rate of adoption (Kotler et al., 1999; Rogers, 2003; Hall, 2005). These attributes are explained further.

1. Relative advantage: The perception of an individual or a social system about the benefits of an innovation is very important. The extent to which this holds may be dependent on the relative economic gains, social prestige factors, convenience and satisfaction (Kotler et al., 1999). Hence an innovation gets adopted faster if its relative advantages are known (Hall, 2005; Rogers, 2003). In the context of this study, this theory may help to determine the advantages in terms of raw material cost, harvesting and processing cost, ease of handling, marketing cost and perception about bamboo.

2. Compatibility: This explains the extent to which an innovation is seen as matching extant values, past experiences and the needs of potential adopters (Rogers, 2003). The more compatible a new idea is with the values and norms of a social system, the more likely it will be adopted. This will help to determine whether or not current wood processing equipment can be used to process bamboo, current grading rules for wood products can be employed for grading bamboo products, or current wood manufacturing processes will change for bamboo manufacturing (Kotler et al., 1999).

3. Complexity: Complexity is the level to which the innovation is seen as difficult to comprehend and use. Such innovations are adopted relatively slower than simple innovations, and require new skills and understandings (Hall, 2005; Rabe, 2006). In this study, we will determine if the use of bamboo will require more resources from adopters or the technical knowledge needed can be provided cheaply.

4. Trialability: The extent to which one may experiment with an innovation to determine its suitability for adoption is trialability. Innovations that can be economically tested before large scale deployment are much more adopted than those that cannot be tried (Kotler et al., 1999; Rogers, 2003). We will determine whether Ghana's forestry infrastructure provides opportunities for adopters to process bamboo products and determine whether markets exist for products.

5. Observability: The results of an innovation can be seen as important if they are observable. An innovation is more likely adoptable if the results of its application are easy to realize (Kotler et al., 1999; Rogers, 2003). Seeing positive outcomes (e.g., product and market performance) from the adoption of bamboo could be an example of observability. Having a facility in Ghana where the industry can obtain training or observe bamboo manufacturing and bamboo products could help increase observability.

Rogers asserts that these five factors are the most important attributes that explain the rate of adoption of innovations. Relative advantage and compatibility are the two most important constructs that explain the rate of adoption of an innovation (Rogers, 2003). These perceived attributes of innovation will be applied in developing questions that seek to determine the barriers and needs of the industry and institutions regarding bamboo adoption.

Post-diction versus Prediction (Acceptability Study)

The general use of perceived attributes such as relative advantage and compatibility to explain the rate of adoption of innovations is tied with situations that already exist. Nevertheless, these generalizations can also be used to predict the rate of adoption of future innovations (Ryan, 1969). This forward-looking research is sometimes called 'acceptability research'. Acceptability research is defined as the investigation of the perceived attributes of an ideal innovation that guides research and development in order to create such an innovation (Rogers, 2003). The purpose of such research is to identify a basis for positioning an innovation to make it more acceptable (Rogers, 2003). An ideal acceptability research design would collect measurements for the attributes of innovations at t_1 in order to predict the rate of adoption for these innovations at some future time t_2 (Rogers, 2003).

Research focused on predicting the rate of adoption of innovations would be more valuable if data on the attributes of the innovation were collected before or together with individuals' decision to adopt the innovation (Hall, 2005; Rogers, 1971). There are many methods that help in predicting future adoption of an innovation. They include:

1. Extrapolating from the rate of adoption of past innovations
2. Describing a hypothetical innovation to its potential adopters, and determining its perceived attributes.
3. Investigating the acceptability of an innovation in its pre-diffusion stages (Rogers, 2003).

This study falls under the acceptability study of innovations, and more appropriately fits the third type of acceptability study mentioned above. It leads to some research questions which follow in latter chapters. Before undertaking an acceptability study such as this, it is important to

understand the concept of innovativeness which is a prerequisite to adoption of innovations. Thus, a discussion on innovativeness follows.

Innovativeness

Innovativeness is the degree to which a potential adopter is earlier in adopting an innovation than other adopters (Ryan, 1969; Lampikoski and Emden, 1996). Knowles, Hansen and Dibrell (2008) define innovativeness as the propensity of firms to create and/or adopt new products, manufacturing processes, and business systems. Adopters of innovations in a social system do not all adopt at the same time. Several factors such as their socioeconomic status and regular use of the mass media determine their agency in adoption. With regards to bamboo, some of these factors may be the level of awareness about bamboo, people's perception about the product and the cost benefits in its adoption.

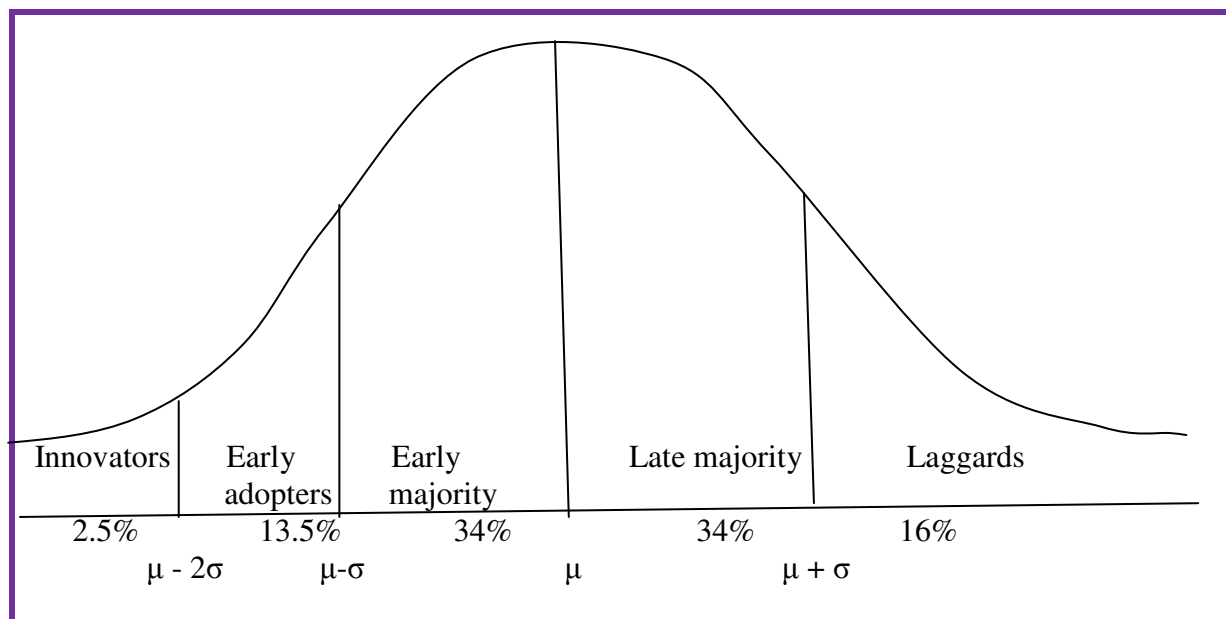


Figure 2.2: Adopter Categorization on the Basis of Innovativeness
Source: Rogers, 2003.

Using the normal frequency distribution, adopters of innovations are classified into five adopter categories; (1) innovators (2) early adopters (3) early majority (4) late majority and (5) laggards (Ryan, 1969; Rogers, 2003). The mean, μ and standard deviation σ , are important measures used to divide a normal adopter distribution into these five categories as shown in **Figure 2.2**.

The innovativeness dimension is measured by the time at which an individual adopts an innovation. The first 2.5% is the area lying to the left of the mean time of adoption, μ minus two standard deviations. These are the innovators. The next 13.5% that adopts the innovation are the early adopters, who fall in the area between $\mu-2\sigma$ and $\mu-\sigma$. The early majority (34%) are included in the area between $\mu-\sigma$ and μ . The late majority (34%) fall in the area between μ and $\mu + \sigma$. The last 16% to adopt innovations are the laggards (Rogers, 2003). This adopter categorization is not symmetrical as there are three adopter categories to the left and only two to the right. Laggards could be in two categories or innovators and early adopters could be combined (Ryan, 1969). Some concepts that are important in helping meet the goal of this study have been noted. Next is the conceptual framework that helps in visualizing the concepts in summary.

The Conceptual Framework

The perceived attributes of innovation, the concept of acceptability study, and the definitions given here for innovativeness and adopter categorization would help in developing variables appropriate for this study. They will also provide guidance for determining the innovativeness of the subjects under study. Based on the objectives and the theoretical foundation, the overall conceptual framework for the study is illustrated in **Figure 2.3**.

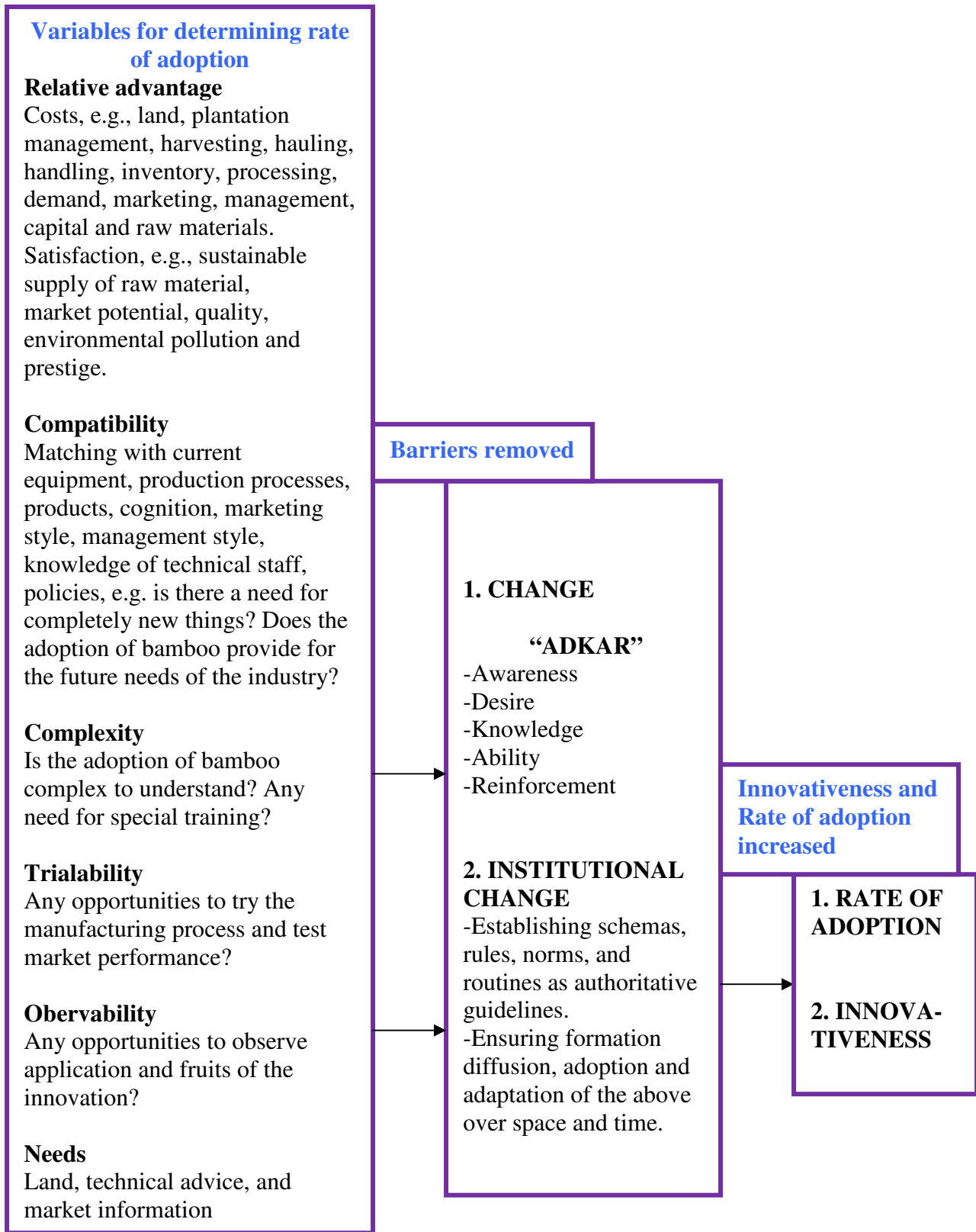


Figure 2.3: A Conceptual Framework for the Study

The left at side of the figure shows the perceived attributes of innovation which describe the various obstacles to an innovation and the benefits it can offer. To ensure sound recommendations of adoption, the change management approach may help in identifying strategies and develop a management framework for the adopting companies (Hiatt, 2006).

Institutional change is concerned with the processes by which structures, including schemas, rules, norms, and routines become established as authoritative guidelines for social behavior. Determining how these elements are formed, diffused, adopted and adapted over space and time and how they lose importance and usability is important (Scott, 2005).

This includes management topics such as the resource-based view, the knowledge-based view, decision-making and networking. Changes in underlying institutional patterns perceived as negative may serve as barriers to adoption of innovations. Good organizational factors facilitate higher rates of adoption (Hage, 2005; Rochlin, 2006).

The change management model will also be useful in implementing the change needed by firms. Organizational change is defined as the process of planning, designing, implementing and internalizing tools, procedures, routines, processes, or systems that will require people to perform their jobs differently (Mourier and Smith, 2001). Leaving the human aspect of organizational change out of the change process can lead to ruin (Mourier and Smith, 2001; Nooteboom, 2005; Evans and Schaefer, 2001; Cameron and Green, 2006). For this study, the Awareness, Desire, Knowledge, Ability and Reinforcement (ADKAR) model developed by Hiatt (2006) is used as a reference framework in the implementation process of bamboo adoption in Ghana's forest products industry.

Some Research Applications of Rogers' Theory of Diffusion of Innovations

Several studies have used Rogers' theory of diffusion of innovations as a theoretical foundation. Bratkovich and Miller (1993) studied the perceived educational needs of innovative Ohio sawmill operators, and they observed that educational needs in forest products marketing and environmental awareness were the most important. Schwarzbach (1999) conducted a study of the diffusion of career development and found that Rogers' model of the innovation process in organizations does not successfully reach beyond the complex communication channels he posits. Lewis (1997) based her work on Rogers' theory and observed that the dissemination process of sales of the products she studied started during the field-testing phase.

The adoption of bamboo as a substitute raw material has some theoretical meaning with respect to environmental sustainability.

Commercial Use of Bamboo and Sustainability

The commercial utilization of bamboo has some other theoretical connotations. Given its short growing cycle and resilient regeneration ability, bamboo could play a good role in environmental sustainability. To explain further, the next discussion explores the basis for and justifies bamboo utilization to supplement timber supply in an environmental sustainability context.

Views of Neoclassical and Ecological Economics on Natural Capital

The 'Critical Natural Capital⁸ and Strong Sustainability' Theory, a component of ecological economics that deals with sustainable development explains other reasons why the use of bamboo is important (Costanza et al., 1996; Duchin, 1996; Burkett, 2006). Ecological

⁸ A stock of natural ecosystem goods such as trees that provide value in a sustainable way

economics concerns solving problems associated with humans and their ecosystems, ensuring equitable distribution of resources and property rights both within the current generation and future generations and between man and other species, and the efficient allocation of resources (Costanza et al., 1996; Martinez-Alier and O'Connor, 1996).

Neoclassical economics and ecological economics have different meanings for natural capital. Neoclassical economics views natural capital as highly substitutable by produced capital such as machines. Ecological economists consider this position 'weak sustainability' in light that it assumes economies can continue to flourish even if the stock of natural capital declines (Duchin, 1996; Tietenberg, 2000). On the other hand, ecological economics views natural capital and produced capital as complementary and supports 'strong sustainability' which restricts production by ensuring that natural capital is non-diminishing (Burkett, 2006; Costanza, et al., 1996).

Neoclassical economic theory of 'resource optimism' postulates that dearth in certain resources would surge prices, engendering substitution of less scarce resources and shifting demand towards the same direction. In addition, scarcity would encourage recycling of wood products, and search for other sources of resources and efficiency in the use of resources. Ecological economics and neoclassical economics disagree on the issue of substitution especially substitution of non-living capital for living capital e.g. machines for living natural resources (Costanza et al., 2001; Tietenberg, 2000). This brings to mind the Hartwick (1977) rule, which states that one can "*invest all profits and rents from exhaustible resources in reproducible capital such as machines*", and the issue of denying future generation their share of the exhaustible resource is solved (Burkett, 2006; Tietenberg, 2000; Bretschger and Egli, 2001).

However, the Hartwick rule only ensures a generalized capacity to produce, rather than an emphasis on a specific resource. This means that, it emphasizes ‘constant capital’, which is impossible and hence described as a concept of ‘weak sustainability’ (Tietenberg, 2000). Burkett (2006) refers to Solow (1974) as saying that there is no cause for alarm if other factors are easily substitutable for natural resources. The need for natural resources thus becomes a secondary issue (Edwards-Jones et al., 2000). However, we are likely to consume all our natural resources as long as their extraction is exponential (Rochin, 1996). Thus, Burkett concludes that, reduction of the human environment to a substitutable resource is not different from the reduction of sustainable development to sustainable capital accumulation.

Critical Natural Capital Strong Sustainability and Weak Sustainability

To meet the goals of ecological economics and sustainable development, some neoclassical economists developed the theory of ‘strong sustainability’, which advocates some preservation of natural capital (Costanza et al., 1996; Tietenberg, 2000; Burkett, 2006). ‘Strong Sustainability’ would require a measurable value of a ‘critical’ (having potential of productive or aesthetic services) natural capital. It is required of critical natural capital to be sustainable and non-substitutable with machines (Edwards-Jones et al., 2000). For example, in Ghana, a natural bamboo forest, a natural capital, is perceived as an ecosystem good that can mitigate industrial wastes, maintain clean air and water, protect the soil from erosion and provide raw material for the forest products industry.

It is clear that nature produces unique goods and services as opposed to goods and services offered by other types of capital. This vindicates the notion of non-substitutability of natural capital (Tietenberg, 2000). However, we need to recognize that natural capital is two-fold: “renewable” and “non-renewable” natural capital (Costanza et al., 1996). Using solar

energy, renewable natural capital is self-supporting e.g. ecosystems, and can yield goods e.g. wood upon harvest, or they can produce a flow of ecosystem services such as erosion control and recreation when left intact (Folke et al., 1996; Costanza et al., 2001).

Until they are extracted, non-renewable natural capital do not produce any services. Renewable natural capital can be likened to buildings and machines in the sense that they depreciate and can be renovated or replaced. To elucidate it further, natural capital can also exist as a mixture of natural and manmade capital or 'cultivated natural capital' as in agriculture, fish farming, livestock management and forestry. In certain functions the cultivated natural capital can substitute for natural capital e.g. planted bamboo substituting for natural timber (Burkett, 2006).

Neoclassical weak sustainability proposes that economic growth is possible given that total capital (natural capital and manufactured) stock remain constant regardless of how small the amount of the natural capital component is. The theory projects that the productivity of natural capital increases as natural capital decreases, with productivity drawing close to infinity whilst natural capital gets close to zero. To ecological economists and natural capital theorists, the concept of weak sustainability is not real based on the level of substitution of manufactured capital (and labor) for natural capital, a stance that conflicts with the precepts of material constraints on production (Tietenberg, 2000; Cleveland et al., 2001; Costanza et al., 2001).

As a positive step, Burkett reveals that substitution of cultivated capital (e.g. planted bamboo) for natural capital is possible but may be negated by the complementary connection between natural and manmade components of cultivated natural capital. As soon as natural capital and manmade capital are complementary and accepted, the more available resource becomes preferable. Increased consumption of natural resources limits resource availability and

may sometimes necessitate use of manmade capital e.g. planted bamboo. Furthermore, ecological economists strongly encourage a corresponding increase in quantity and substitution of renewable natural capital for the lost non-renewable natural capital (Edwards-Jones et al., 2000; Ayres, 2001; Bretschger and Egli, 2001; Costanza et al., 2001; Burkett, 2006).

It seems reasonable from the discussion to propose the use of natural or planted bamboo to supplement or substitute for wood in Ghana on the basis that it is supported by the ‘Critical Natural Capital and Strong Sustainability’ theory. Bamboo grows fast and regenerates quickly. It would increase the resource base for the wood industry and ensure sustainable fiber supply. Bamboo stands offer many services to the environment, e.g., oxygen circulation, erosion control, and flows of products such as bamboo culms for commercial utilization in the wood industry. What is more, it would contribute greatly to the preservation of the natural forest in Ghana, a key factor required in the critical natural resource strong sustainability theory. It is important to educate the forest products industry and other stakeholders about the benefits that are associated with the adoption of natural capital such as bamboo. As observed earlier, there are both tangible and intangible benefits in adopting bamboo. In developing awareness creation and corporate social responsibility programs, it is hoped that if these benefits are made known to adopters, their desire to adopt bamboo might increase.

Literature Cited

Afuah, A. 1998. *Innovation Management: Strategies, Implementation, and Profits*. Oxford University Press, New York. 403pp.

Ayres, R. U. 2001. *The Need for A Growth New Paradigm*, In: Cleveland, C., D. I. Stern, and R. Costanza. (Eds.), *The Economics of Nature and the Nature of Economics*. Edward Elgar Publishing, Northampton, MA, USA. 293pp.

Bratkovich, S. M. and L. E. Miller. 1993. *Perceived Educational Needs of Innovative Ohio Sawmill Operators*. *Forest Products Journal*. 43(3): 35-40.

Bretschger, L. and H. Egli. 2001. Sustainable Growth in Open Economies, In: Schulze, G. G. and H. W. Ursprung. (Eds.), International Environmental Economics: A Survey of the Issues. Oxford University Press Inc., New York. 301pp.

Burkett, P. 2006. Marxism and Ecological Economics: Toward a Red and Green Political Economy. Koninklijke Brill NV, Leiden, The Netherlands. 355pp.

Cameron, E. and M. Green. 2006. Making Sense of Change Management: A Complete Guide to the Models, Tools and Techniques of Organizational Change. Kogan Page Ltd. London. 280pp.

Carayannis, E. G., E. M. Rogers, K. Kurihara and M. M. Allbritton. 1998. High-technology Spin-offs from Government R&D Laboratories and Research Universities. *Technovation*. 18(1): 1-11.

Cleveland, C. J., R. Costanza, and D. I. Stern. 2001. Introduction: The Changing Nature of Economics – Towards and Ecological Economics, In: Cleveland, C., D. I. Stern, and R. Costanza. (Eds.), *The Economics of Nature and the Nature of Economics*. Edward Elgar Publishing, Northampton, MA. 293pp.

Costanza, R., S. Farber, B. Castaneda and M. Grasso. 2001. Green National Accounting: Goals and Methods, In: Cleveland, C., D. I. Stern, and R. Costanza. (Eds.), *The Economics of Nature and the Nature of Economics*. Edward Elgar Publishing, Northampton, MA, USA. 293pp.

Costanza, R., O. Segura, and J. Martinez-Alier. (Eds.), 1996. *Integrated Envisioning, Analysis, and Implementation of Sustainable and Desirable Society, Getting Down to Earth: Practical Applications of Ecological Economics*. International Society for Ecological Economics, Island Press, Washington D. C. 472pp.

Duchin, F. 1996. Ecological Economics: The Second Stage, In: Costanza, R., O. Segura, and J. Martinez-Alier. (Eds.), *Getting Down to Earth: Practical Applications of Ecological Economics*. International Society for Ecological Economics, Island Press, Washington D. C. 472pp.

Edwards-Jones, G., B. Davies and S. Hussain. 2000. *Ecological Economics: An Introduction*. Blackwell Science Ltd., Malden, MA. 266pp.

Evans, J. and C. Schaefer. 2001. *Ten Tasks of Change: Demystifying Changing Organizations*. Jossey-Bass/Pfeiffer. San Francisco. 270pp.

Folke, C., J. Larsson, and J. Sweitzer. 1996. Renewable Resource Appropriation by Cities, In: Costanza, R., O. Segura, and J. Martinez-Alier. (Eds.), *Getting Down to Earth: Practical Applications of Ecological Economics*. International Society for Ecological Economics, Island Press, Washington D. C. 472pp.

Hage, J. 2005. Organizations and Innovations: Contributions from Organizational Sociology and Administrative Science, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A*

Multidisciplinary Review of the Study of Innovation Systems. Edward Elgar Publishing Ltd., UK. 307pp.

Hall, B. H. 2005. Innovation and Diffusion, In: Fagerberg, J., D. C. Mowery and R. R. Nelson, The Oxford Handbook of Innovation. Oxford University Press Inc., New York. 656pp.

Hiatt, J. M. 2006. ADKAR: A Model for Change in Business, Government and Our Community. Prosci Research, Loveland, CO. 146pp.

Hill, C. W. L. and G. R. Jones. 2004. Strategic Management: An Integrated Approach. 6th Edition. Houghton Mifflin Company, New York. 482pp.

Holbeche, L. 2006. Understanding Change: Theory, Implementation and Success. Elsevier, Oxford. 455pp.

Kahn, E. 2007. Innovate or Perish: Managing the Enduring Technology Company in the Global Market. John Wiley & Sons. Inc. Hoboken, New Jersey. 303pp.

Knowles, C., E. Hansen and C. Dibrell. 2008. Measuring Firm Innovativeness: Development and Refinement of a New Scale. Journal of Forest Products Business Research. 5(5): 1-26.

Kotler, P., G. Armstrong, J. Saunders, and V. Wong. 1999. Principles of Marketing. 2nd European Edition. Prentice Hall, Europe. 1031pp.

Kozmetsky, G. 1991. The Challenge of Technology Innovation: The New Globally Competitive Era, In: Gibson, D. V. (Ed.), Technology Companies and Global Markets: Programs, Policies and Strategies to Accelerate Innovation and Entrepreneurship. Rowman & Littlefield Publishers, Inc., Maryland. 399pp.

Kuczumarski, T. D. 1996. Innovation: Leadership Strategies for the Competitive Edge. NTC Publishing Group, Chicago, IL. 210pp.

Lampikoski, K. and J. B. Emden. 1996. Igniting Innovation: Inspiring Organizations by Managing Creativity. John Wiley & Sons. New York. 222pp.

Lewis, G. A. 1997. Leadership Products as Innovations in the Context of Rogers' Diffusion Theory. Ph.D. Dissertation. Dept. of Vocational and Technical Education, Virginia Polytechnic Institute and State University, Blacksburg, VA. 187pp.

Ljungberg, S. 1982. How Can a Well Organized I&D Service Help to Improve the Innovation Process in a Company? In: B. T. Stern (Ed.), Information and Innovation. North-Holland Publishing Company, Amsterdam. 191pp.

Mahajan, V. and R. A. Peterson. 1985. Models for Innovation Diffusion. Sage Publications Inc., CA. 86pp.

- Martinez-Alier J. and M. O'Connor. 1996. Ecological and Economic Distribution of Conflicts, In: Costanza, R., O. Segura, and J. Martinez-Alier. (Eds.), *Getting Down to Earth: Practical Applications of Ecological Economics*. International Society for Ecological Economics, Island Press, Washington D. C. 472pp.
- Mourier, P. and M. Smith. 2001. *Conquering Organizational Change: How to Succeed Where Most Companies Fail*. CEP Press, Atlanta, GA. 212pp.
- Nooteboom, B. 2005. Innovation, Organizational Learning and Institutional Economics, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems*. Edward Elgar Publishing Ltd., UK. 307pp.
- Rabe, C. B. 2006. *The Innovation Killer: How What We Know Limits What We Can Imagine and What smart Companies are Doing About It*. American Management Association, New York. 219pp.
- Rochlin, D. 2006. *Hunter or Hunted? Technology, Innovation and Competitive Strategy*. Thompson Higher Education. Mason, Ohio, USA. 306pp.
- Rogers, E. M. 1971. *Communications of Innovations: A Cross-cultural Approach*. 2nd Edition. MacMillan Publishing Co. Inc., New York. 475pp.
- Rogers, E. M. 2003. *Diffusion of Innovations*. 5th Edition. Free Press, New York. 551pp.
- Ryan, B. 1969. *Social and Cultural Change*. The Ronald Press Company. New York. 496pp.
- Schmoch, U., C. Rammer, and H. Legler. 2006. Research and Development Activities in the German Sector, In: Schmoch, U., C. Rammer, and H. Legler (Eds.), *National Systems of Innovation in Comparison: Structure and Performance Indicators for Knowledge Societies*. Springer, The Netherlands. 314pp.
- Schwarzbach, L. G. 1999. *A Process Study of the Diffusion of Career Development*. Ph.D. Dissertation. Educational Leadership and Policy Studies. Virginia Polytechnic Institute and State University, Blacksburg, VA. 166pp.
- Scott, W. R. 2005. Institutional Theory, In: Ritzer, G., *Encyclopedia of Social Theory*. Thousand Oaks, CA: Sage Publications. 982pp.
- Sedjo, R. A. 1999. Land Use Change and Innovation in U.S. Forestry, In: Simpson D. R. (Ed.), *Productivity in Natural Resource Industries: Improvement through Innovation*. Resources for the Future, Washington, DC. 220pp.
- Simpson, R. D. 1999. Technological Innovations in Natural Resource Industries, In: Simpson R. D. (Ed), *Productivity in Natural Resource Industries: Improvement through Innovation*. Resources for the Future, Washington, DC. 220pp.

Tietenberg, Tom. 2000. Environmental and Natural Resource Economics. 5th Edition. Addison Wesley Longman, Inc., Reading, MA. 630pp.

Unger, B. 2005. Problems of Measuring Innovation Performance, In: Casper, S. and F. Waarden (Eds.), Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems. Edward Elgar Publishing Ltd., UK. 307pp.

CHAPTER 3: ASSESSING CURRENT SITUATION IN GHANA'S FOREST PRODUCTS INDUSTRY AND FUTURE STEPS

Introduction

This chapter deals with the current situation in Ghana's forest products industry. Some reports have shown that the industry is currently experiencing difficulties due to the declining raw material base (Eastin, 2003; Bank of Ghana, 2004; GFC, 2006). To help safeguard the situation, the government is now selling government owned plantation teak to companies to supplement timber supplied from natural forests (GFC, 2006). Apart from raw material shortages, other constraints that affect the industry include inability to invest in state-of-the-art equipment, rising internal costs, lack of skilled personnel, costly loan acquisition procedures in the Ghana banking system (GFC, 2004), and poor production techniques (ITTO, 2006). Whether these constraints or others arise as a result of the low raw material supply is not clear.

Furthermore, the extent to which the industry is impacted by raw material decline is unknown. This raises a question to answer about how much the industry is impacted by the raw material shortage. To obtain current information that will facilitate proposing future steps that are appropriate, this study has investigated the current status of the industry by identifying the log felling volumes of leading exporters and the scope of the industry (products, volumes, location, markets). Future steps that lead to the adoption of bamboo could assure the industry's continual survival.

Objectives

The goal of this study is to determine the current situation of Ghana's forest products industry. To achieve this goal the following objectives need to be met.

(i) To determine the scope of the industry e.g., volume of logs consumed, volume of products exported, scope of products and markets and the benefits the industry offers to communities.

(ii) To determine the impact of raw material decline on the industry.

These objectives will help in proposing future steps that may need to be taken to ensure sustenance in the forest products industry. The following methods help in achieving the goal of the study.

Methods and Data Collection

Population, Sample Frame and Sample

The total number of companies in Ghana's forest products industry is estimated to be 200 (GFC, 2004). This number is questioned as companies enter and go out of business and this is not recorded in updates of industry directories. For example, at the time of this study, some companies still in directories were no longer in existence. This study focused on leading exporters of tertiary (downstream) and panel (plywood and particleboard) products. The total number of companies studied was 26, purposively obtained from the most recent published list of principal exporters by the Ghana Timber Industry Development Division (TIDD) (GFC, 2004). Data were collected from leading exporters in the four timber producing regions, Ashanti, Western, Brong-Ahafo and Eastern. **Figure 3.1** shows the regional distribution of the companies studied. A map of Ghana showing the regions is shown in **Appendix A**.

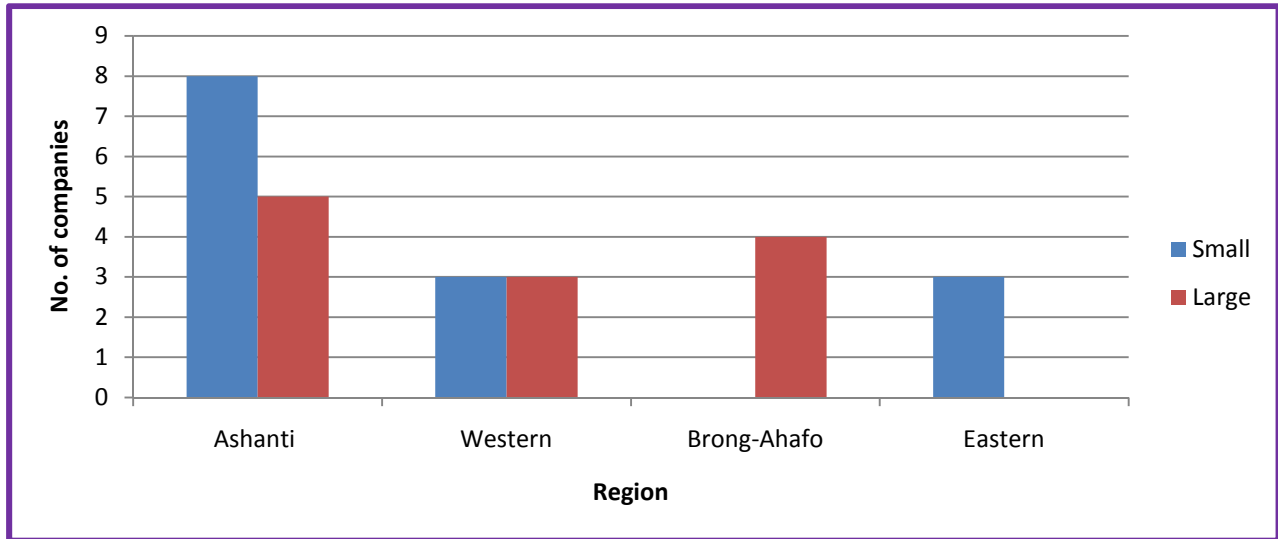


Figure 3.1: Regional Distribution of Companies Studied

Companies in the industry are generally considered small if they have less than 500 employees and large if they have above 500 employees. Fifty percent (i.e., 5 large and 8 small) of the companies studied are located in the Ashanti region, 23% (i.e., 3 large and 3 small) in the Western region, and 15% (4 large) and 12% (3 small) in the Brong-Ahafo and Eastern regions respectively. As stated earlier, about 20 large companies in the industry account for 90% of Ghana’s wood product export volume and 66% of value, while approximately 160 small and medium sized companies account for 34% of export value (Bank of Ghana, 2004). Focusing on the leading exporters was a good representation of the industry as they account for most of the exports. The dominant product exported by these companies is kiln-dried lumber. However, this study focused on the downstream processors and panel product manufacturers (who invariably produce kiln-dried lumber) because they are more likely to use smaller diameter raw materials, a possible way of maximizing the timber raw material base.

Determining the Impact Variables Using the Indicators of Natural Resources Scarcity⁹

As indicated in Chapter 1, the forest products industry in Ghana over the past few decades has suffered a decline in timber raw material supplies. In addition to my own assumptions and experience, some of the variables for determining the impact of raw material decline on the industry were obtained from the indicators of natural resources scarcity (Cleveland and Stern, 1998). Generally, an increase in scarcity is defined by a decline in economic well-being due to a reduction in the quality, availability or productivity of a resource (Cleveland and Stern, 1993). The classical, neoclassical and biophysical models of scarcity are used to determine these indicators (Conrad, 1999; Cleveland and Stern, 1998). The classical model assumes that it is more difficult and costly labor-wise to extract scarce forest resources due to their declining quality and remoteness (e.g. from rough terrains as opposed to gentle terrains). The neoclassical model of scarcity posits that stumpage rent and price increase with increased scarcity (Conrad, 1999).

The biophysical model of scarcity assumes that the cost of energy increases with resource scarcity due to the reduced resource quality which is accompanied by high energy demand and emission of residuals. Changes in the quality of resources affect energy cost of extraction and capital costs for residuals (Cleveland and Stern, 1998). From these theoretical standpoints, the variables for determining the impact of raw material decline on the industry were designated. The variables are rise in operation cost, rise in adoption of lesser-used species, rise in raw material cost, drop in raw material availability, difficulty in procuring raw material, and drop in export volume and value. The rest are, drop in chances of loan acquisition, downsizing,

⁹ Factors e.g. price, labor cost, production cost etc. which rise as a result of resource decline

workforce reduction, loss of customers and rise in export tax payments. These variables will help in determining the degree to which the industry has been impacted by raw material shortage.

Data Collection

Data for the study was gathered from November 2007 to February 2008 through personal interview surveys of CEOs i.e. managing directors of the 26 leading exporters of value added and panel products in the country. The respondents were interviewed using a semi-structured interview schedule (Dillman, 2000; Houtkoop-Steenstra, 2000; Aldridge and Levine, 2001; Neuman, 2003; Alreck and Settle, 2004). Color coded rating cards were handed out to respondents to facilitate responses to structured questions (Alreck and Settle, 2004). Open-ended data were recorded in writing. This study was one part of a larger study. The whole interview process lasted between 30 minutes and 1 hour. After the data was collected and conveyed to Virginia Tech, a plan was developed for its further handling.

Data Handling

Each completed questionnaire was reviewed on the day of its completion to correct responses to open ended questions that were poorly worded. Most questions were pre-coded before the survey was administered. However, questions that were not coded before data collection got post-coded after the survey administration. After the interview process, some of the questions were re-coded into narrower categories in order to facilitate analysis of the data. For example, the structured survey items were scaled at five-point intervals (i.e. 1-5%, 6-10% etc.) in the questionnaires but re-coded to 10-point intervals (i.e. 1-10%, 11-20% etc.) during data handling to provide adequate data for each survey item for analysis. Data was entered into the SPSS and Excel software processing programs and analyzed.

Data Analysis and Results

Size and Scope of Leading Exporters

The leading exporters of downstream processed products and panel products are located in four regions as shown in **Figure 3.1**. Fifty percent of these exporters are in the Ashanti region (most of them in Kumasi), 23% in the Western region and the rest distributed among the Eastern and Brong-Ahafo regions. The total workforce for the 26 companies studied was 20,311 (**Table 3.1**). The largest company employs 3,500 workers and the smallest employs 12. Seven large companies employ more than 1,000 workers each. A total of 12 companies have workforce above 500 (designated large companies) and 14 companies have workforce below 500 (designated small companies).

Table 3.1: Workforce of Companies Studied

Total number of companies	26
Workforce total	20,311
Minimum	12
Maximum	3,500

Most of the companies studied run more than one shift of 8 hours; 31% run three shifts, 50% two shifts and 19% one shift (see **Table 3.2**). Most of the companies running two shifts or one were previously running one extra shift but the decline in raw material availability has resulted in a decrease in the number of shifts run currently.

Table 3.2: Number of Shifts Run by 26 Leading Exporters

Number of shifts	Frequency	Percent of companies
One shift	5	19.2
Two shifts	13	50.0
Three shifts	8	30.8
Total	26	100.0

Production Volumes of Leading Exporters

The annual volume consumption of logs as reported by 25 respondents is 1,124,688m³ (see **Table 3.3**). This value surpasses the annual allowable cut of 1,000,000m³ which implies that timber is being harvested unlawfully.

Table 3.3: Consumption and Production Volumes of Logs and Products

	Volume (m ³) of logs consumed (N=25)	Volume (m ³) of products produced (N=24)
Mean per month	3,749	1,614
Total per month	93,724	38,732
Total per year	1,124,688	464,784

Given that these companies are leading exporters, it is not surprising that they consume that much log input volume. However, adding the volume consumed by the remaining companies in the industry would mean that timber is alarmingly being overexploited.

The corresponding volume yield of products has been an improvement over previous outputs as a result of the downstream processing which even extends to the use of rejected rotary cores for profiles. This demonstrates the effect of technology in improving natural capital, i.e., obtaining as much as possible from natural capital. This kind of activity helps save the forest.

However, there may still be the need for substitution of wood with fast growing species such as bamboo. Most of the products produced shown in **Table 3.3** are exported. The next section presents the product profiles discovered in the study and their markets.

Table 3.4: Product Profile of Leading Exporters

Product	Number of companies	Percent of companies producing product
Kiln-dried lumber	19	73.1
Molding	18	69.2
Flooring	13	50.0
Plywood	13	50.0
Air-dried lumber	12	46.2
Profile boards	12	46.2
Rotary veneer	11	42.3
Doors	10	38.5
Sliced veneer	9	34.6
Broomsticks	9	34.6
Treated lumber	8	30.8
Dowels	7	26.9
Furniture	6	23.1
Air-dried boules ¹⁰	6	23.1
Windows	5	19.2
Carvings	4	15.4
Veneer curls	3	11.5
Kiln-dried boules	2	7.7
Treated poles	2	7.7
Handicrafts	2	7.7

¹⁰ Logs sawn through to obtain slabs with bark intact; these boards are bound together to look again like logs-they are exported without further processing. They can be best described as patched logs. Companies do this to defeat the purpose of log export ban.

Product Profiles and Markets of Leading Exporters

Ghana's forest products industry manufactures several products for export. **Table 3.4** shows the export product profile of the industry. Nineteen companies of those surveyed that export downstream and panel products also export kiln-dried lumber. The most dominant tertiary (downstream) product is molding, which is manufactured by 18 of the companies studied. Fifty percent of respondents manufacture and export floorings and plywood. Other tertiary export products not included in **Table 3.4** include finger jointing, S4S lumber, T&G, decking, laminated particle board, door accessories, cabinet doors, cabinet wood accessories, casement, and Venetian windows. Most of these products can be processed from small diameter timber, discarded off-cuts, and lesser-used species or from other natural fiber materials such as bamboo. As shown in **Table 3.5**, about 85% of the leading exporters export to Europe while 50% export to African countries and North America. About 35% of respondents export to Asian countries while approximately 27% export to the Middle East. A major product exported from Ghana to other African countries is plywood. Doors and windows are also exported to African countries.

Table 3.5: Respondents' Regional Distribution of Product Exports

Region	Frequency	Percent
Europe	22	84.6
Africa	13	50.0
North America	13	50.0
Asia	9	34.6
Middle East	7	26.9

Before determining the impact of raw material decline on the industry, it is important to identify some of the reasons why the industry is important. It is especially important to know the

benefits that the industry offers to neighboring communities. In the next section, the benefits that the industry offers communities are identified.

Benefits Offered by Industry to Communities

The industry offers several benefits to neighboring communities. Employment is the most obvious mentioned form of benefits (**Table 3.6**). Most respondents also mentioned building and rehabilitation of schools as a major benefit they offer to their communities. Other important benefits include building of clinics and hospitals, construction of roads in forest operation areas and provision of potable water systems e.g. boreholes. This list of benefits demonstrates the industry’s commitment to societal welfare and the country’s economic growth. As long as the industry continues to operate, neighboring communities will benefit

Table 3.6: Benefits Offered by Companies to Communities

<ol style="list-style-type: none"> 1. Employment 2. Building and rehabilitation of schools 3. Building of clinics and hospitals 4. Construction of roads in forest operation areas; change wooden bridges to concrete bridges 5. Provision of potable water systems e.g. boreholes 6. Repair of police vehicles 7. Assistance in electrification projects; provide electric poles 8. Building of palaces for chiefs 9. Assistance to churches in fund raising 10. Supply of roofing material to institutions 	<ol style="list-style-type: none"> 11. Building and rehabilitation of police stations 12. Supply of wood products <ul style="list-style-type: none"> • Wood for local market • Fuel wood 13. Assistance in general community projects 14. Assistance to district assemblies <ul style="list-style-type: none"> • Donations • Community development 15. Assurance of corporate social responsibility <ul style="list-style-type: none"> • Assist in poverty alleviation projects • Help farmers to grow plantations with cash crops, e.g., citrus
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As **Table 3.6** shows, the forest products industry contributes in various ways to the development of communities in Ghana. That known, one would be curious to further determine how much the industry has suffered from raw material decline as this might impact their benevolent services to neighboring communities. The next section explores this.

Impact of Raw Material Decline on the Industry

It was assumed that the dwindling raw material base has impacted the industry. To this end, mills were asked to rate the level of impact of declining supply of raw material felt in the past five years. Some of these variables are indicators of natural resources scarcity (Cleveland and Stern, 1998). **Table 3.7** shows the number of respondents who indicated whether raw material decline has impacted their operations or not to some degree.

A 'yes' response to the question means that the company has been impacted to a certain percentage. A 'no' response means that the company has not been impacted. For some questions, up to four respondents could not determine the degree to which they have been impacted. The table shows that most companies have been impacted by raw material decline. The rise in adoption of lesser-used species, rise in raw material cost, drop in raw material availability and other raw material related variables are factors that have affected most companies. Companies which have not been affected by increased raw material cost or lower availability are probably using cheaper lesser-used species.

Table 3.7: Impact of Raw Material Decline on Industry (N=26)

Impact on Industry	Yes	No	Cannot determine value
Rise in operation cost	21	1	4
Rise in adoption of lesser-used species	21	4	1
Rise in raw material cost	19	3	4
Drop in raw material availability	23	3	-
Increase in difficulty in procuring raw material	23	2	1
Drop in export volume	22	3	1
Drop in export value	22	4	-
Drop in chances of loan acquisition	16	9	1
Downsizing	16	10	-
Workforce reduction	15	11	-
Loss of customers	15	11	-
Rise in export tax payments	5	21	-

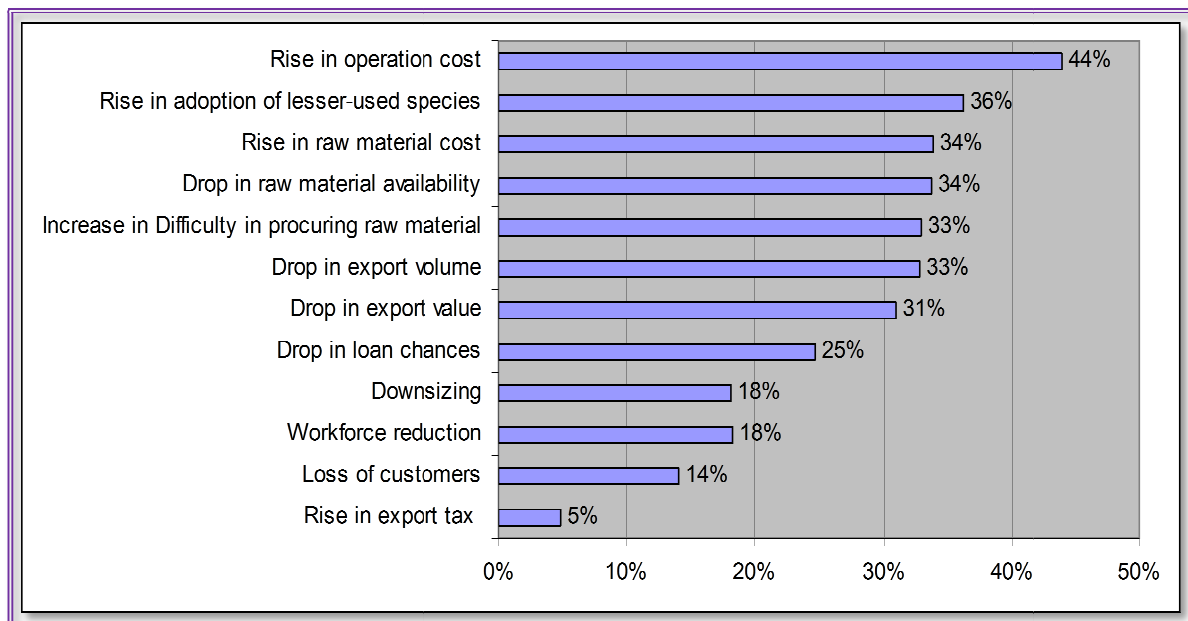


Figure 3.2: Impact of Raw Material Decline on Industry in the Past 5 Years (N=26)

The impact felt by the industry as a result of timber raw material decline has been dramatic (Figure 3.2). The average rise in operation cost of 44% indicates that many companies are facing

a critical financial crisis. Rise in operation cost is however attributed to other market forces such as fuel cost and utility tariffs. The figure shows that there has been an increased drop in raw material availability and an increase in raw material cost of 34%. It is more difficult now for companies to procure quality raw material. In the past five years, companies replaced the indigenous premier species with lesser-used species by about 36%. Export volume and value have also dropped as a result of the decline in the natural raw material base.

Other impact factors include drop in chances of loan acquisition, downsizing, and loss of customers. Export tax payments have remained very low in the past five years. Previously, the government had taxed companies higher with the intent of discouraging overexploitation to stimulate downstream processing. Other consequences faced by the industry not necessarily due to raw material supply decline gathered from open-ended questions are shown in **Table 3.8**.

Table 3.8: Other Impacts on the Wood Industry

<ul style="list-style-type: none"> • Difficulty paying salaries • Inability to pay bills on time • Inability to pay workers on time • Inability to meet social obligations • Increased wages • Increased tariffs i.e. water and electricity • High of cost inputs e.g. spare parts and glue for panel products • High fuel prices; shipping costs go up; fuel constitutes about 30% of operation cost • Poor co-operation from government • Small log sizes; poor quality • Shifting workers to other departments – this is de-motivating and requires new training 	<ul style="list-style-type: none"> • Competition from other regions • Price of products determined by international markets • Inability to meet all customer needs • Inability to meet delivery schedules • Inability to pay high stumpage fees promptly • Inability to buy new equipment • No new investment in industry • Problem with illegal chain saw operators • Complex certification requirements complex • Little help from government in certification
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It is clear that the industry is faced with many problems. So ensuring adequate supply of raw material is perceived to be helpful in mitigating the problems faced by the industry. The companies were examined based on size groups (small and large) to determine any differences in means. This would help in validating any potential government assistance programs.

Mean Comparisons

Due to the extremely large sizes of some of the companies and the small nature of others, the study sample was categorized into small and large companies to determine the degree of impact on each category. As stated earlier, companies in the industry in Ghana are generally considered small if they have less than 500 employees and large if they have more than 500 employees. The distribution was 14 small and 12 large companies. All the variables were not found to be normally distributed and the standard errors differed, so a non-parametric Mann-Whitney U test was used to compare the means between small and large companies (Kent, 2001; Alreck and Settle, 2004).

The results in **Table 3.9** indicate a significant difference with respect to increase in difficulty in procuring quality raw material, at an alpha level of 0.05 ($p= 0.041$) with means 38.9% and 26.7% for small and large companies respectively. There is also a significant difference in the means of loss of customers i.e. 20.7% and 6.3% respectively for small and large firms ($p=0.044$). It is significantly more difficult for smaller companies to procure raw material and many have lost customers than larger companies. Apart from these two variables, both small and large companies suffer the same degree of impact as a result of the raw material decline. There is no significant difference in means with respect to the other variables. The importance of raw material decline was also determined with respect to location of company, i.e., companies in the Ashanti region (13) and those in other regions (13).

Table 3.9: Mean Comparison for Raw Material Impact with Size of Company

Impact	Size	N	Mean%	p-value
Rise in raw material cost	Small	12	31.25	.737
	Large	10	37.00	
	Total	22	33.86	
Drop in raw material availability	Small	14	37.86	.126
	Large	12	28.75	
	Total	26	33.65	
Drop in export volume	Small	14	38.57	.239
	Large	11	25.45	
	Total	25	32.80	
Drop in export value	Small	14	36.07	.306
	Large	12	24.58	
	Total	26	30.77	
Increase in difficulty in procuring raw material	Small	13	38.85	.041
	Large	12	26.67	
	Total	25	33.00	
Rise in adoption of lesser-used species	Small	14	35.71	.956
	Large	11	36.82	
	Total	25	36.20	
Loss of customers	Small	14	20.71	.044
	Large	12	6.25	
	Total	26	14.04	
Downsizing	Small	14	16.43	.957
	Large	12	20.00	
	Total	26	18.08	
Workforce reduction	Small	14	18.57	.829
	Large	12	17.92	
	Total	26	18.27	
Rise in export tax payments	Small	14	3.21	.125
	Large	12	6.67	
	Total	26	4.81	
Drop in chances of loan acquisition	Small	13	33.69	.189
	Large	12	15.00	
	Total	25	24.72	
Rise in operation cost	Small	12	46.67	.785
	Large	10	40.50	
	Total	22	43.86	

Table 3.10 shows the mean comparisons for companies in the Ashanti region and with mills in other regions regarding the impact of raw material decline on the companies. The results indicate that there is no significant difference in the means of the impact factors, (e.g., rise in raw material cost, drop in raw material availability and drop in export volume) with respect to the location of the companies. All companies with respect to the two categorized locations (Ashanti versus all other regions) have experienced a similar degree of impact due to raw material decline. They may all need alternative fiber materials to supplement current raw material supplies confirming the need for alternative raw material supplies. To determine how the factors are related, a correlation analysis was performed.

Table 3.10: Mean Comparison for Raw Material Impact with Location of Company

Impact	Location	N	Mean%	p-value
Rise in raw material cost	Ashanti Region	10	39.50	.338
	Other Regions	12	29.17	
	Total	22	33.86	
Drop in raw material availability	Ashanti Region	13	36.15	.567
	Other Regions	13	31.15	
	Total	26	33.65	
Drop in export volume	Ashanti Region	12	29.17	.423
	Other Regions	13	36.15	
	Total	25	32.80	
Drop in export value	Ashanti Region	13	26.15	.299
	Other Regions	13	35.38	
	Total	26	30.77	
Decreased raw material quality	Ashanti Region	12	32.08	.779
	Other Regions	13	33.85	
	Total	25	33.00	
Rise in adoption of lesser-used species	Ashanti Region	13	34.62	.795
	Other Regions	12	37.92	
	Total	25	36.20	
Loss of customers	Ashanti Region	13	11.15	.412
	Other Regions	13	16.92	
	Total	26	14.04	
Downsizing	Ashanti Region	13	19.23	.794
	Other Regions	13	16.92	
	Total	26	18.08	
Workforce reduction	Ashanti Region	13	16.92	.776
	Other Regions	13	19.62	
	Total	26	18.27	
Rise in export tax payments	Ashanti Region	13	3.46	.594
	Other Regions	13	6.15	
	Total	26	4.81	
Drop in chances of loan acquisition	Ashanti Region	12	28.67	.557
	Other Regions	13	21.08	
	Total	25	24.72	
Rise in operation cost	Ashanti Region	10	48.00	.472
	Other Regions	12	40.42	
	Total	22	43.86	

Correlation Analysis

The appropriate technique used to test the degree and significance of the relationship between two continuous variables from interval or ratio scales is correlation or regression analysis (Alreck and Settle, 2004). In regression analysis, one variable must be designated independent and the other dependent. However, due to the small sample size for this study, regression analysis would not yield favorable results (Hair et al., 2006). In correlation analysis, only the extent to which variables are related or tend to move together is measured. There is no assumption of a cause and effect among variables (Alreck and Settle, 2004; Kent 2001).

Table 3.11 shows the correlations between different raw material impact factors and the drop in export volume determined in the study. The factors include rise in raw material cost, drop in raw material availability, increased difficulty in procuring quality raw material, rise in the adoption of lesser-used species and drop in export volume. Strong correlations indicate that the factors are strongly associated with each other. At the 95% level of significance, rise in raw material cost strongly correlates with drop in raw material availability ($p < 0.01$).

Table 3.11: Pearson Correlations for Raw Material Related Factors and Drop in Export Volume

		Rise in raw material cost	Drop in raw material availability	Increased difficulty procuring	Rise in adoption of lesser-used species	Drop in export volume
Rise in raw material cost	Pearson Correlation	1.000	.725**	.517*	.179	.291
	Sig. (2-tailed)		.000	.014	.438	.201
	N	22	22	22	21	21
Drop in raw material availability	Pearson Correlation	.725**	1.000	.728**	-.169	.497*
	Sig. (2-tailed)	.000		.000	.420	.011
	N	22	26	25	25	25
Increased difficulty procuring	Pearson Correlation	.517*	.728**	1.000	-.246	.714**
	Sig. (2-tailed)	.014	.000		.247	.000
	N	22	25	25	24	24
Rise in adoption of lesser-used species	Pearson Correlation	.179	-.169	-.246	1.000	-.308
	Sig. (2-tailed)	.438	.420	.247		.143
	N	21	25	24	25	24
Drop in export volume	Pearson Correlation	.291	.497*	.714**	-.308	1.000
	Sig. (2-tailed)	.201	.011	.000	.143	
	N	21	25	24	24	25
**Correlation is significant at the 0.01 level (2-tailed).						
*Correlation is significant at the 0.05 level (2-tailed).						

This implies that companies may find it difficult to procure raw material as shortages occur alongside increased procurement costs. Increased difficulty in procuring raw material strongly correlates with drop in raw material availability and drop in export volume ($p < 0.01$).

This indicates that companies may not be able to export high volumes of products as raw material procurement becomes more difficult. They may have to adopt alternative species to sustain production. There is a negatively weak correlation between rise in the adoption of lesser-used species and increased difficulty in procuring raw material. This could mean that the adoption of lesser-used species reduces the difficulty in procuring raw material to some extent. Rise in the adoption of lesser-used species does not have any significant correlation with the other variables. The highest correlation associated with it is -0.308 i.e., 'drop in export volume' which is a negative correlation between the variables. Although the correlation is weak, it indicates that the adoption of lesser-used species has enhanced export volumes to some extent. Adoption of lesser-used species has been common in the industry for many years now. As observed earlier, markets for lesser-used species are growing. So it is possible now some companies are using mostly lesser-used species. In such cases, their increased use could have a limited effect on current export volumes.

Conclusions

Ghana's forest products industry remains important in the country's employment and economic growth. The industry is large and has a diverse product profile and market base. It serves communities in many other ways, e.g., building of schools and hospitals. Nevertheless, decline in the natural raw material base appears to be an apparent obstacle to the industry's future survival. Although deforestation is attributable to other factors such as fuel wood collection and farming, timber harvest above the annual allowable cut (determined by the department of forestry through timber allocation to companies) cannot be compromised. The 26 canvassed companies annually consume timber raw material in the excess of the annual allowable cut (AAC).

The purpose of this chapter was to determine the current situation in the timber industry and the impact of raw material decline on the industry to suggest strategies appropriate to bridge the raw material supply gap. It was discovered that most firms manufacture moldings, floorings and/or plywood all of which can be made from bamboo.

The variable with the biggest impact on the industry as reported by respondents is operation cost. This is attributable to several factors including fuel prices, electricity and water tariffs and raw material cost. In the past five years, there has been 36% increase in the adoption of lesser-used species. This is not a surprise as the stocks of premier species which were in lowland forests where logging was easier now remain only on top of mountains where accessibility is difficult. It is more costly to go further into these rough terrains to extract timber and the quality of the timber in such rough terrains is poor. Smaller companies find it more difficult than larger companies to procure raw material, and have lost customers to larger companies. To survive, small companies need support from the government, e.g., access to plantations and loans.

Other difficulties faced by the industry include, difficulty paying salaries, increased tariffs i.e. water and electricity, high cost of inputs and small-sized logs. Many of the problems facing the industry stem from the decline in raw material supply. Finding alternative to the declining natural timber base is critical and bamboo, a fast growing fiber species could serve as such alternative. The industry needs to be proactive and adopt bamboo to ensure its future survival-an innovation that is important in ensuring firm competitiveness and sustained competitive advantage (Bonsi, Gnyawali and Hammett, 2008). The Ghana government should develop modalities that increase adoption of bamboo to save the forest products industry.

Literature Cited

- Alreck, P. L. and R. B. Settle. 2004. *The Survey Research Handbook*. 3rd Edition. McGraw-Hill/Irwin, Inc. USA. 463pp.
- Aldridge, A. and K. Levine. 2001. *Surveying the Social World: Principles and Practice in Survey Research*. Open University Press. Buckingham, Philadelphia. 196pp.
- Bank of Ghana. 2004. *Report on the Timber Industry in Ghana*. Research Department. Sector Study Series. 1(1): 1-33.
- Bonsi, R., D. Gnyawali and A. L. Hammett. 2008. *Achieving Sustained Competitive Advantage in the Forest Products Firm: The Importance of the Resource-based View*. *Journal of Forest Products Business Research* 5(3): 1-14.
- Cleveland, C. J and D.I. Stern, 1998. *Indicators of Natural Resource Scarcity: A Review and Synthesis*, in J.C.J.M. van Bergh(Ed.), *Handbook of Environmental and Resource Economics*. Edward Elgar Publishing Ltd. 1300pp.
- Cleveland, C. J and D. I. Stern. 1993. *Productive and Exchange Scarcity and Empirical Analysis of the US Forest industry*. *Canadian Journal of Forest Research* 23(15): 37-49.
- Conrad, M. J. 1999. *Resource Economics*. Cambridge University Press. New York. 213pp.
- Dillman, D. A. 2000. *Mail and Internet Surveys: The Tailored Design Method*. 2nd Edition. John Wiley & Sons, Inc. 464pp.
- Eastin, I. L. 2003. *Toward the more Effective Marketing of Lesser-Used Tropical Timber Species: A Theoretical Framework*. *Ghana Journal of Forestry*. 11(2): 1-13.
- Ghana Forestry Commission. 2004. *A News Letter about Ghana's Forests, Timber and Wildlife*. Ghana Gazette. No. 32. June/July. 11pp.
- Ghana Forestry Commission. 2006. *A News Letter about Ghana's Forests, Timber and Wildlife*. Ghana Forestry Commission. Ghana Gazette. No. 38. First Quarter. 12pp.
- Hair, J. F., W. C. Black, B. J. Babin, R. E. Anderson and R. L. Tatham. 2006. *Multivariate Data Analysis*. 6th Edition. Pearson Education Inc., Upper Saddle River NJ. 899pp.
- Houtkoop-Steenstra, H. 2000. *Interaction and the Standardized Survey Interview. The Living Questionnaire*. Cambridge University Press, New York. 209pp.
- ITTO. 2006. *Tropical Timber Market Report*. 11(20): 1-21.
- Kent, R. 2001. *Data Construction and Data Analysis for Survey Research*. Palgrave Publishers Ltd., New York. 251pp.

Neuman, W.L. 2003. Social Research Methods: Qualitative and Quantitative Approaches. 5th Edition. Pearson Education Inc., Allyn and Bacon Inc., Boston, MA. 584pp.

CHAPTER 4: ADOPTION OF BAMBOO BY GHANA'S FOREST PRODUCTS INDUSTRY

Introduction

This chapter is concerned with the adoption of bamboo as perceived by managing directors/general managers in the forest products industry in Ghana. It was observed in Chapter 3 that leading exporters alone consume timber at levels in excess of the annual allowable cut to meet their installed capacity and markets. As companies still cannot adequately supply their mills with needed timber raw material, many of them have reduced their three or two 8-hour production shifts by two or one respectively. The impact of declining raw material on the industry is high. Raw material costs have increased, quality has decreased and export volumes have plummeted in the past years. Meanwhile, apart from providing benefits such as employment, the industry also builds schools and hospitals in neighboring communities. To sustain the industry and ensure its continual contribution to the country's economy and its assistance to neighboring communities, the adoption of alternative raw material might be helpful.

Adoption of bamboo to supplement timber may be one of the ways to slow or reverse the trend in natural timber raw material decline. Bamboo matures fast and is capable of producing two to six times more cellulose per hectare than pine (Chen et al., 2000). Bamboo is used for a variety of products including housing, furniture, and paper, and is becoming an important substitute for wood in flooring and other indoor products because of its beautiful stripes, color and other desirable attributes (Brito and Cevallos, 2004).

To determine the potential for adoption, a preliminary informal survey was undertaken in the summer of 2006 in New York City to determine the availability of bamboo products in some retail stores. Some products imported from Vietnam and China and which can be produced in

Ghana include bamboo parquet, full bed, TV cabinet, night stand, and coffee table. Prices for some of the products were recorded. For example, whereas a bamboo bento full bed costs \$1,399, a similar product made from cherry costs \$699.95. A bamboo nightstand costs \$429 while a cherry nightstand costs \$229.95. Commercialization of bamboo is becoming increasingly evident in the global retail market. This cursory look gave some evidence about the market potential for bamboo products and beacons a venture into bamboo processing. With the current market evidence in bamboo products, it is important that Ghana consider its commercial processing and utilization.

As stated in Chapter 1, Oteng-Amoako et al. (2004) conducted a countrywide preliminary study to collect general information (e.g., species, dealers, products and harvesting) about bamboo in Ghana and observed certain barriers that need to be removed. For home use, common woodworking tools can be used to cut, drill or join pieces of bamboo culms together. However, given its innate splitting tendency, before its wide acceptance for commercial use, research is needed to determine cheaper and better ways of processing it (Hershey, 2004). All these findings need further investigation to determine the feasibility of introducing bamboo in Ghana's forest products industry.

The survey sought to help identify the barriers and needs perceived by managing directors/general managers that may impact the rate of adoption of bamboo as a raw material in the tertiary and panel sectors of the wood industry. The ability of companies to overcome certain barriers was used to determine their level of innovativeness or receptiveness to the change. Suggestions elicited from respondents that help formulate better policies towards improved management and marketing strategies and proper utilization of bamboo and bamboo products in

Ghana were also collected. Using the results of the study and reference from the innovation and management literature, change management models have been developed and presented in Chapter 6 to serve as a framework for the successful adoption of bamboo in the forest products industry.

Given its size, bamboo is more suitable for products with intricate parts as is the case in tertiary (e.g., furniture) and panel products. A review of the literature substantiates that bamboo has been successful in these product categories (Sumardi et al., 2006; Hiziroglu et al., 2005; Ruiz-Perez et al., 2001; Paudel and Moran, 2004; Weber, 2002; Brito and Cevallos, 2004).

The principal exporters of these products are the focus of this study, as they produce 90% of the volumes of wood product exports (Bank of Ghana, 2004). Furthermore, according to the theory of diffusion of innovations, giants and opinion leaders are always followed by the rest of society (or their peers) once they exhibit leadership in adoption (Rogers, 2003; Mahajan and Peterson, 1985). The leading exporters of these products (e.g., furniture, flooring, molding, profiles) and panel products make up the sample of 26.

Objectives

The objectives of this study are:

(i) To identify barriers and needs (e.g. quality, capital, cost, cognition, marketing, management, equipment, etc.) in the adoption of bamboo as a raw material in the tertiary and panel sectors of the wood industry as perceived by managing directors i.e. CEOs and general managers.

(ii) To develop policy instruments for all stakeholders for the successful adoption of bamboo in the industry.

Research Questions

The preceding literature review and theoretical foundation discussed in Chapter 2 have revealed research questions that need further investigation. Specifically, the five perceived attributes of innovation are considered to be important constructs that can help in identifying barriers to adoption of bamboo. In the questionnaires, some of these barriers were used to frame questions that seek to measure the level of commitments respondents are willing to make in the bamboo adoption process. They also help in determining the innovativeness of industry respondents and their needs. Therefore, three research questions (R1, R2 and R3) have been identified and presented in this section.

The identification of needs (e.g. financial, land and education) and barriers are important in meeting the goals of this study. For example, several studies have been done to identify educational needs in the forest products industry. Bratkovich and Miller (1993) conducted a study on the perceived educational needs of innovative Ohio sawmill operators based on Rogers' theory of diffusion of innovations and the results appear to be relevant to this study. They discovered forest products marketing and creation of environmental awareness to be the most important in the perceived educational needs of the innovative operators (Bratkovich and Miller, 1993).

In another study, educational needs were assessed in the Canadian wood products industry. The findings show that, to remain competitive, the Canadian wood industry needs to have access to a technically intelligent workforce that can promote innovation (Barrett and Cohen, 1996). Another study on the employment structure and training needs in the Louisiana value-added wood products industry observed that employers were reluctant to add to their labor force because of lack of adequate skilled personnel. The study advocated a timely response by

industry experts, vocational-technical systems, equipment manufacturers and community colleges to bridge this gap through in-house training, training manuals, personal visits and off-site training facilities, and short courses (Vlosky and Chance, 2001).

In developing a methodology for determining extension education needs in the forest products industry in the U.S., it was discovered that, there are similarities in the needs of companies across the states despite some differences in size and products (Bowe et al., 1999). The educational needs of the companies varied according to company size and manufacturer type. Educational needs in marketing and management were found to be the most important. They also observed that different segments of the forest products industry (small and large, primary and secondary) invariably, have different needs (Bowe et al., 1999).

Several studies have been undertaken in the wood industry to identify barriers that might impact the adoption of alternative species. Eastin (2003) showed that a lack of adequate technical, market and product performance information, and cost of market research are some of the key barriers to the adoption of lesser-used species in Ghana's forest products industry. Ellefson and Stone (1984) identified institutional and technical barriers as major obstacles that affect the forest products industry when venturing into a new activity. Based on the literature review and Rogers' five attributes of innovation, the following research questions have evolved.

R1: What are the barriers perceived by companies, policymakers, educational institutions, scientists, and related stakeholders in the adoption of bamboo as a new fiber source in the tertiary and panel sectors of Ghana's wood industry?

As Rogers (2003) points out, not all innovations are desirable, e.g. some innovations may not be feasible economically or may not be benign. In addition, an innovation could be wise for one category of subjects but unwise for another. This implies that depending on company size

and product type, there could be differences in the propensity of companies to adopt bamboo as a raw material. Some authors have raised questions as: what types of firms are more likely to innovate? Is it small or large companies (Afuah, 1998)? There have been several debates about this issue (Acs and Audretsch, 1991; Afuah, 1998; Unger, 2005).

According to some authors, Schumpeter was the first to assert that small entrepreneurial firms were the most likely to innovate (Afuah, 1998; Hippel, 1988; Unger, 2005). He later asserted that large companies are more likely to be innovative as they have the resources to commercialize innovations. Their size also enables them to use economies of scale to harness R&D, and they have access to capital (Afuah, 1998; Hippel, 1988; Unger, 2005). Wagner and Hansen (2005), in their study to determine the innovativeness of small and large forest products firms in the U.S., observed that firm size is important in determining the type of innovation to be pursued.

It is important to know the level of innovativeness found in small versus large companies because this will guide the formulation of policies that promote bamboo utilization. For, example questions such as the following need to be answered. Will large companies that have more resources and ability to bid higher prices for the scarce timber resources through the timber utilization contract (TUC)¹¹ be interested in using bamboo? If small companies are not able to bid for timber contracts, will they more likely support adoption of bamboo? Will small companies be left with only bamboo as their choice? Will large companies consider adopting bamboo? To investigate these gaps, a second research question is necessary.

R2: What firm attributes are important in the adoption of bamboo by the tertiary and panel (plywood and particle board) product sectors of Ghana's forest products industry?

¹¹ TUC is the mode in which timber companies bid for timber concessions. The highest bidders win. It could be difficult for firms with inadequate resources to compete.

Arguably, innovative capacity depends on the systems of institutions that are in place to support or constrain adoption. Such institutions are organizations that provide incentives, resources and opportunities to support the innovation or serve as barriers to adoption. Examples of such institutions include financial institutions, research organizations, and training and educational organizations (Eliasson, 2001; Feldman and Massard, 2002; Waarden, 2005). The innovative capacity in a country (its potential as both a political and economic entity to produce a flow of commercially useful innovations) determines, to a large extent, the innovative success of that country (Porter and Stern, 2002). Innovation requires sustained investment by nations in research, physical capital and human resources (Porter, 1990). Given these realities, a third research question is important.

R3: Are policymakers, educational institutions and affiliated associations important in influencing the adoption of bamboo in the industry?

Methods and Data Collection

Based on these three research questions appropriate methods were determined. Semi-structured interviews were administered to the managing directors/general managers of the companies. This has been deemed appropriate for similar studies (Neuman, 2003; Houtkoop-Steenstra, 2000; Aldridge and Levine, 2001; Alreck and Settle, 2004). The questions sought to determine the barriers and needs perceived by the managing directors that might impact the adoption of bamboo in the forest products industry. Perceptions were also gathered through open-ended questions that would help develop appropriate policies needed for the management, utilization and marketing of bamboo and bamboo products.

Population and Sample Frame and Sample

As indicated earlier, there are approximately 200 wood processing mills in Ghana. However, the focus of this study was the leading exporters of tertiary products (including furniture, flooring, moldings) and panel products (plywood and chipboard). The focus was on the leading exporters because this study seeks to determine the feasibility of using bamboo for commercial and industrial products to supplement similar exportable wood products.

Data collection from the subjects of the industry was in the Ashanti region (the Kumasi city and its precincts), the Western region (the Takoradi city and its precincts), the Brong-Ahafo region (the Sunyani city and its precincts), and the Eastern Region (all in Akim Oda). The survey covered four of the existing 10 regions in the country where most of the country's forest resource and industry are concentrated. The remaining six regions have little or no commercial timber business. **Appendix A** shows a map of Ghana including the sample frame. The sample of 26 mills was obtained from the most recent list of principal forest product exporters published by the Ghana Forestry Commission (GFC, 2004).

Overall Project Management

The next steps of the research project included development of the survey questions, pretesting the survey, administering the survey and data handling. Full replicas of the questionnaires are shown in **Appendices C and D**.

Overview of Survey Questions

The survey questions addressed issues related to the industry and institutions. Questions for the industry listed some impact variables that respondents were asked to scale to determine the current situation in the industry. Respondents in the industry were also asked to provide information about their current awareness about bamboo and how possible it is for them to undertake various activities to show their receptiveness to bamboo. The industry and institutions were asked to provide information about the resources that are available to them in the current situation that would enable them to adopt or promote bamboo. Respondents were also asked in open-ended questions to provide a list of perceived barriers to adoption of bamboo. They were also canvassed about their needs. Respondents were canvassed about the appropriate policy instruments for the adoption of bamboo in Ghana.

Pretest

In order to have an idea about likely barriers, the survey for the industry was pretested with the few small-scale companies that have bamboo plantations or are producing bamboo products. This was done within the last few days of November and the early days of December 2007. The pretest also included a few managers that are producing wood products. For instance, earlier in the summer of 2007, the questionnaire was pretested with a production manager of one of the companies in Ghana who visited Washington, DC. During pretesting, responses to the open-ended questions were very important in improving the original questionnaire and helped in identifying some barrier variables and variables for innovativeness. The pretest was helpful in identifying and clarifying questions that were poorly framed. Data collection commenced after the questionnaires were finalized.

Data Collection

Interviews were conducted between late November 2007 and early February 2008. The managers were canvassed using a semi-structured interview schedule (Dillman, 2000; Houtkoop-Steenstra, 2000; Aldridge and Levine, 2001; Neuman, 2003; Alreck and Settle, 2004). The survey instrument for the industry is shown in **Appendix C**.

The same data collection process was employed for institutions whose results are presented in the next chapter. The walk-in approach was used to meet the respondents. The purpose of the visit was explained and its authenticity proved at each company's security gate by presenting a business card and the Virginia Tech Institutional Review Board (IRB) approval certificate before entry to the mill was allowed. In some companies, qualified respondents were first contacted by the security personnel for permission before admission was allowed. Entry was allowed in all cases. At companies where both the MDs and the GMs were absent, revisits were necessary.

Each interview session started with an explanation of the purpose of the visit and presenting all supporting documents in hand (recruitment letter, IRB approval certificate, researcher business card). The few respondents who had limited time at the first visit scheduled a return visit. The recruitment document, which was written to inform respondents that their participation was voluntary and that they were free to withdraw at anytime was shown to each respondent (industry and institutions) before the interview commenced. As respondents knew that they had the choice to withdraw at anytime, they were motivated to continue the interview process to the end. **Appendix B** is copy of the recruitment letter.

Color coded rating cards were given out to respondents to facilitate responses to structured questions (Alreck and Settle, 2004). Structured questions were read to all respondents

and they needed only to mention the codes they thought best described their answers. Many respondents expressed satisfaction and excitement at looking at the well designed rating cards and hence easily responded to the questions. Open-ended questions were also read out to the respondents. All data were recorded in writing. On average, the interview lasted between 30 minutes and 1 hour. The data collection process involved extensive driving. Approximately 6,000 kilometers were driven during data collection. Once the data was conveyed to Virginia Tech, handling, entry and analysis commenced.

Data Handling

Each completed questionnaire was reviewed on the day of the interview to ensure responses to open-ended questions were correctly worded. Most questions were pre-coded before the survey was administered. However, questions that were not coded before data collection were post-coded after the survey administration. A detailed codebook was developed to help in data coding and entry. Data was entered into the SPSS and Excel software processing programs which were used to analyze the data.

In the following section, methods that were used for analysis are discussed. The results of the study are also presented. Factors discussed include normality of data, reliability statistics for scales, and statistical measures of association e.g. Mann-Whitney U tests, One-Way ANOVA, Chi², Contingency tables and binomial tests. Next is the discussion on data analysis and results.

Data Analysis

Using the SPSS software, mean responses were calculated to determine the degree to which the survey items and variables are important. To ensure cross validation of the data given the small sample size, analyses were done for both survey items and variables. The standard

deviation and percent of responses were obtained to show the spread and distribution of the data. The One-Way analysis of variance (ANOVA) and Mann-Whitney U tests were conducted to compare mean differences for some responses. The analyses in this chapter indicate the barriers perceived, the pertinent needs and the innovativeness of firms.

As the respondents have not yet adopted bamboo as a new material, innovativeness in this study may also imply the receptiveness of the respondents to the adoption of bamboo. All open-ended data was analyzed descriptively and qualitatively. Results from Chapters 3, 4, and 5 are synthesized with innovation and change management literature to develop models presented in chapter six for the successful adoption of bamboo by the industry in Ghana. To satisfy the conditions of ANOVA the next section determines the normality of the data.

Normality of Data

The coefficients of skewness and kurtosis were used to determine the normality of the scaled interval data in order to determine the appropriate statistical analysis to use (Hair et al, 2006; Alreck and Settle, 2004; Kent, 2001). A measure of skewness which is less than one or minus one is a general indication that the distribution is approximately normal in shape (Hair et al, 2006; Kent, 2001). Kurtosis is a measure of the degree to which the values cluster around the mean. The value is zero for a normal distribution, negative for a low cluster around the mean, and it will be positive for a high cluster around the mean (Kent, 2001). Given the preceding definitions, it is clear that all the items on the numeric scale i.e. 'availability of land' with a skewness value of 0.036 to 'opportunities to acquire loans' with a skewness of 0.02 are approximately normal and can be analyzed with the One-Way ANOVA analogous to the t-test (see **Table 4.1**).

Table 4.1: Normality Statistics for Survey Items

Item	Skewness	Kurtosis
Company may acquire more land	-1.454	2.000
Company may manage own plantation	-1.734	4.310
Company may install new equipment	-1.496	4.325
Company may train new managers	-1.890	5.305
Company may develop new products	-2.136	8.071
Company may do more research about bamboo	-1.843	5.665
Company may buy new harvesting equipment	-1.489	3.441
Company may convince customers	-1.886	7.152
Company may look for new customers	-1.843	5.665
Company may adapt some production lines	-1.886	5.367
Company may change some production lines	-.948	5.941
Company may incur marketing cost	-1.312	3.441
Company may convince the public	-2.244	7.152
Company may to follow government policies	-1.843	5.665
Company may invest financially	-1.929	5.367
Company may treat products with preservatives	-1.849	5.941
Availability of land	.036	-.953
Availability of technical advice	.088	-1.309
Availability of market information	.218	-1.093
Product development capability	.439	-.728
Examples to show how bamboo is being used	.378	-1.161
Opportunities for company to try the innovation	.847	-.448
Opportunities for company to observe innovation	.859	-.218
Qualified personnel	.325	-1.247
Financial resources	.145	-1.363
Information about uses of bamboo	-.121	-1.547
Information about bamboo processing	.202	-1.595
Opportunities to acquire loans	.020	-.769

The items on the Likert scale, i.e., ‘company may acquire more land’ with a skewness - 1.454 to ‘company may treat products with preservatives’ with a skewness -1.849, are not normally distributed. However, as survey data is usually not normally distributed (Alreck and Settle, 2004), the asymmetric nature of the data will allow analysis with ANOVA. Nonetheless, the Mann-Whitney U test is used to analyze the non-normal scale items (Kent, 2001). The results

from the kurtosis confirm the results from the skewness. The items on the numeric scale may be interpreted to mean that the variables i.e. survey items are clustered to a lower degree than the Likert items. To ensure that the scales employed for the study are appropriately developed, meaningful and reliable, reliability statistics were obtained for the various scales.

Reliability and Validity Statistics for Scales used in the Study

To ascertain the reliability and validity of the scales used for the study, a reliability test was done for the various scales. Chronbach's alpha is the measure of internal reliability for scales (Kent, 2001). It uses the average correlation among items in a scale and makes adjustments for the number of items. Reliable scales are those with high average correlations and a high number of items. Chronbach's coefficient of reliability is zero when there is no reliability and one when there is a maximum reliability. An alpha value of 0.5 to 0.6 is generally considered reliable (Kent, 2001). All the scales and survey items employed in this study are highly reliable and valid showing high values for Chronbach's alpha (**Table 4.2**). Given the likelihood that there might be high variability in responses to the survey, reliability was calculated for normal and standardized scores to determine the extent of such likelihood. The differences in alpha values for the normal and standardized items are negligible. This confirms a high level of reliability and the validity of the reported scores and vindicates their use in all the analyses. The statistical measures used for the study are discussed next.

Table 4.2: Reliability Statistics for Scales used in the Study

Scale	Number of Items	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
Likert (industry)	16	.961	.962
Numeric (industry)	12	.838	.844
Paired comparison (industry)	10	.953	.957
Numeric (institutions)	11	.787	.786
Likert (institutions)	42	.946	.945

Statistical Measures of Association

The most popular statistical tools used to measure the relationship between two survey variables include contingency table analysis (Cross-tabs), ANOVA, discriminant analysis, regression analysis and correlation analysis. Recalling the research questions and the conditions under which these statistics can be used, One-way ANOVA (analogous to the t-test), Mann-Whitney U test and contingency table analyses are the most appropriate tools in this case (Alreck and Settle 2004). The small sample size does not allow for multivariate analysis.

Factors considered as firm attributes are size, product profile and location of company. The attributes are nominal categorical variables and are the independent variables. The dependent variable is 'adoption' or 'innovativeness'. This study is an acceptability study and the innovation (bamboo) has yet to be introduced. Hence, we cannot predict future adoption based on past adoption levels. Thus, the willingness or receptiveness (innovativeness) of companies to adopt bamboo in the future is used to determine the likelihood of adoption in the future in this case. 'Adoption', 'innovativeness' and receptiveness are thus used interchangeably.

Adoption/innovativeness is also a nominal categorical variable with values 1 and 2. Since both the dependent and independent variables are nominal and categorical the appropriate statistical tool to use is Cross-tabulation (Alreck and Settle, 2004). In this procedure, Chi-square

will measure the degree to which observed values depart from expected values. This will help predict the level of significance (Hair et al, 2006, Alreck and Settle, 2004; Kent, 2001).

Industry Study Results and Discussion

Next, we seek to use the industry responses to answer research questions 1, 2 and 3. The factors of importance are firms' attributes, innovativeness, the barriers that exist, the needs of the firms and policy suggestions toward developing strategies for the successful adoption of bamboo. Due to the limited sample size, as much information as possible is needed to cross validate the results. While some tables show results for analysis of survey items, others show results for categorized variables of the survey items to ensure cross validation.

Barriers, Firm Attributes and Innovativeness

In response to part of research question 1 (R1) and objective 1, the barriers to the adoption of bamboo as perceived by industry CEOs are discussed under this section. The relative importance of the survey items and variables is also presented. Predetermined barriers in the questionnaires were scaled and the ability of companies to overcome them was considered to be a measure of their level of commitment to the adoption (referred to here as their traits of innovativeness) or their receptiveness to the innovation. Using survey items for analysis, **Figure 4.1** shows a summary of the perceived barriers and the mean responses for the possibilities of companies to overcome the barriers to adoption. **Appendix E** shows some of the descriptive results indicating the range of responses for each survey item by each subject group.

On a five-point scale, the companies are least innovative in their readiness to change current production lines to process bamboo with a score of 3.6 (**Figure 4.1**). They are also less ready to acquire more land (mean=3.7) or manage their own plantations (mean=3.7). Companies

appear to be more ready to convince their customers to buy bamboo products (mean=4.1). They are also more ready to invest financially and adapt their current production lines to process bamboo (mean=4.2). Companies are most innovative in their willingness to convince the public that bamboo is a good material with a mean score of 4.3.

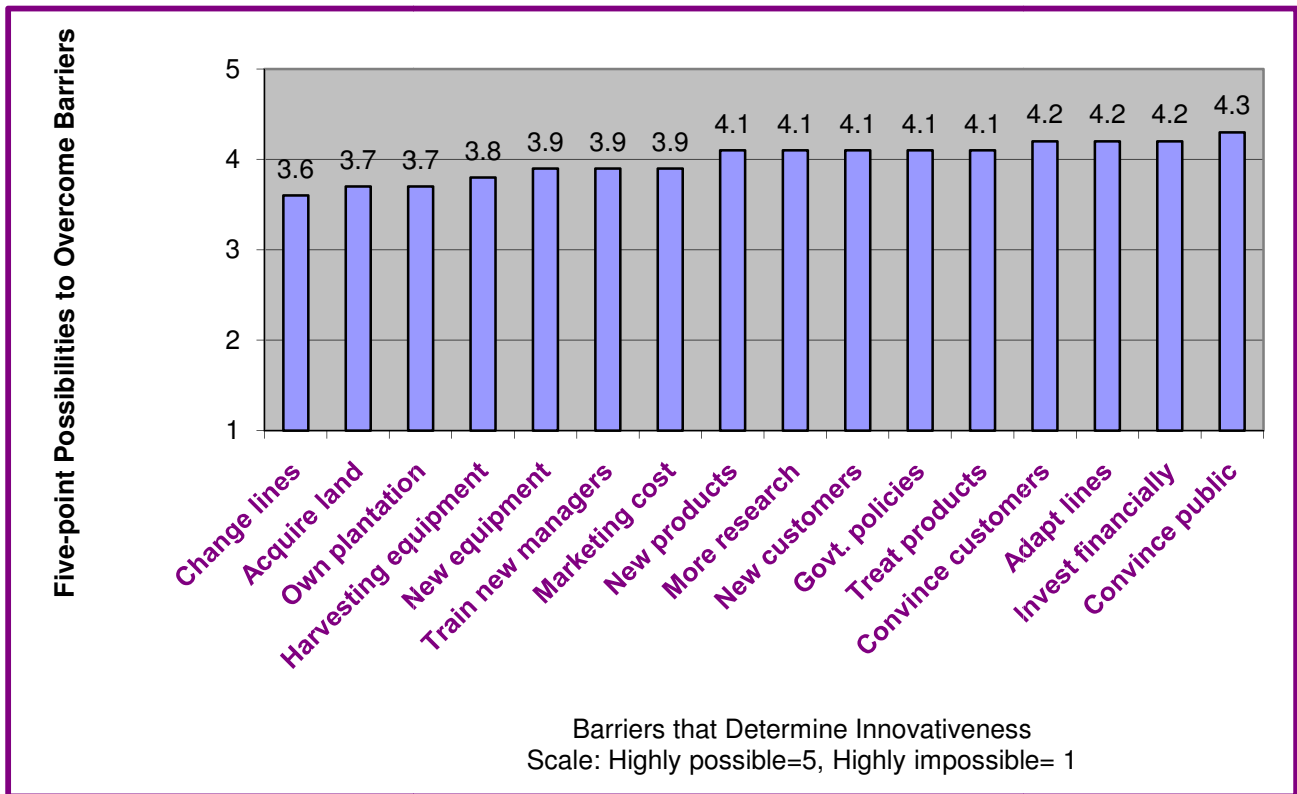


Figure 4.1: Mean Responses for Possibilities to overcome Barriers to Adoption (Traits of Innovativeness) Using Survey Items

Variable Analysis of Innovativeness

As indicated earlier, the firm attributes that were considered important in determining the adoption of bamboo are size, product profile and location of company. The response items were categorized into the three types of innovativeness identified in the forest products sector. These are product, process, and business systems innovativeness (Hovgaard and Hansen, 2004; Cao and Hansen, 2006; Hansen, Juslin and Knowles, 2007; Knowles, Hansen and Dibrell, 2008;

Crespell and Hansen, 2008). Product innovation in this case is product development in new ways that satisfy customer needs. Process innovation in the forest products industry refers to improved processes such as improved efficiency in raw material utilization, computer aided manufacturing and customized machinery (Hovgaard and Hansen, 2004). Other types of innovation that do not fall in the purview of product or process innovation are referred to as business systems innovation (e.g., management and marketing) (Hovgaard and Hansen, 2004). This study has identified factors for product and process innovativeness but for business systems, only marketing is the focus. Therefore, the areas of innovativeness for this study are product, process and market innovativeness.

With reference to literature, survey items that were considered to be indicators of product innovation include readiness to develop new products, and the readiness to treat products with chemical preservatives. Items for process innovation include readiness to install new processing equipment and readiness to adapt existing production lines to process bamboo. Market innovation includes factors such as readiness to look for new customers and bear marketing cost (Hovgaard and Hansen, 2004; Cao and Hansen, 2006; Hansen, Juslin and Knowles, 2007; Knowles, Hansen and Dibrell, 2008; Crespell and Hansen, 2008). Means were calculated for each variable, i.e., type of innovativeness. For instance, a mean value for all the items related to product innovativeness (readiness to develop new products, readiness to do product research, and readiness to treat products with preservatives) was obtained (**Table 4.3**). The items for process innovativeness include readiness to change current production lines to process bamboo, readiness to acquire land for bamboo plantations, willingness to purchase bamboo harvesting equipment, and readiness to purchase new processing equipment. Others include willingness of companies to follow government policies, willingness to adapt production lines, and readiness to invest

financially. The items used for market innovativeness include readiness of companies to train new marketing managers, readiness to bear marketing cost and convince customers to buy bamboo products and readiness to attempt to convince the public that bamboo is a good alternative raw material.

The mean values in **Table 4.3** show that smaller companies are more ready to do all types of innovation than larger companies.

Table 4.3: Mean Comparison of Type of Innovativeness with Company Size

Variable	Size	N	Mean	Std. Deviation	p-value
Market Innovativeness	Small	14	4.28	.42762	.448
	Large	12	3.95	.99133	
	Total	26	4.13	.74607	
Product Innovativeness	Small	14	4.39	.28947	.070
	Large	12	3.83	1.01005	
	Total	26	4.13	.75722	
Process Innovativeness	Small	14	4.08	.37853	.715
	Large	12	3.79	.96433	
	Total	26	3.94	.71079	

Statistically, the Mann-Whitney U test shows a slight significant difference ($p=0.070$ at $\alpha=95\%$) between the mean values of smaller companies and larger companies (i.e. 4.39 and 3.83 respectively) in product innovativeness. This is an indication that smaller companies are more ready to do product innovation than larger companies. It supports the fact that, one of the smaller companies has already tried bamboo processing. There is no significant difference in the means of large and small companies in market and process innovation. This indicates that both groups of companies have a similar capacity for market and process innovation. **Table 4.4** shows the mean comparison of type of innovativeness (variables) with respect to location of company.

Table 4.4: Mean Comparison of Type of Innovativeness with Location

Variable	Location	N	Mean	Std. Deviation	p-value
Market Innovativeness	Ashanti Region	13	4.26	.40319	.715
	Other Regions	13	4.00	.97980	
	Total	26	4.13	.74607	
Product Innovativeness	Ashanti Region	13	4.35	.37172	.184
	Other Regions	13	3.91	.97329	
	Total	26	4.13	.75722	
Process Innovativeness	Ashanti Region	13	4.17	.36278	.077
	Other Regions	13	3.72	.90016	
	Total	26	3.94	.71079	

Companies in the Ashanti region are more likely to be innovative in markets (mean=4.26 versus 4.00), product development (mean=4.35 versus 3.91) and process development (mean=4.17 versus 3.72) than companies in other regions. There is no significant difference between the means. However, there is a slight significant difference ($p=0.077$) between the means of companies in the Ashanti region and those in other regions with respect to process innovativeness. This means that companies in Ashanti should be more ready to do process innovation than companies in other regions.

Table 4.5 indicates the mean responses for type of innovativeness (variables) with respect to companies' product profiles. The industry has traditionally produced six secondary wood products (boules, lumber, plywood, sliced veneer, rotary veneer and some other product e.g., moldings). Diversification has led to inclusion of other products such as tertiary products. So it is reasonable to suppose that a traditional company that would like to expand its product profile may have to include downstream processing which is the only new activity to increase the product range.

Seven products or more are considered to be a broad range of products, i.e., the traditional products plus two new products, e.g., furniture and floorings, and six products or less to be a narrow range of products. As the means show, companies with broader product profiles appear to be more innovative in all the three variables (market, product and process). However, there is no significant difference in the mean responses.

Table 4.5: Mean Comparison of Type of Innovativeness with Product Profile

Variable	Product Profile	N	Mean	Std. Deviation	p-value
Market Innovativeness	Narrow product profile	15	4.04	.92025	.731
	Broad product profile	11	4.25	.42039	
	Total	26	4.13	.74607	
Product Innovativeness	Narrow product profile	15	4.05	.91215	.484
	Broad product profile	11	4.24	.49645	
	Total	26	4.13	.75722	
Process Innovativeness	Narrow product profile	15	3.91	.87457	.693
	Broad product profile	11	3.98	.43465	
	Total	26	3.94	.71079	

Adequacy of data for small samples helps in cross validation and authentication of results. Hence the following section presents survey item analysis. The survey item analyses are compared with the variable analyses to draw some conclusions.

Survey Item Analysis of Innovativeness

Survey items were also analyzed to determine the importance of means, differences and their significances. In **Table 4.6** the mean comparison of innovativeness (survey items) with size of company are shown. A Mann-Whitney U test at 95% alpha level shows that, there is a significant difference in the means of responses of small and large companies in their readiness

to train new managers ($p=0.043$). There is also a significant difference between the means of responses of the small and the large companies in their readiness to develop new products ($p=0.023$). With a p-value of 0.048, smaller companies have again demonstrated a higher propensity to treat products with chemical preservatives than larger companies.

Table 4.6: Mean Comparison of Innovativeness with Size (Survey Items)

Survey Item	Means for size (N=26)			p-value
	Small (N=14)	Large (N=12)	Total N=26	
Company may have to				
Acquire more land	3.93	3.50	3.73	.156
Manage own plantation	3.71	3.75	3.73	.636
Install new equipment	4.21	3.67	3.96	.141
Train new managers	4.29	3.58	3.96	.043
Develop new products	4.43	3.75	4.12	.023
Do more research about bamboo	4.29	4.00	4.15	.818
Buy new harvesting equipment	4.00	3.75	3.88	.535
Convince customers to buy bamboo products	4.36	4.08	4.23	.734
Look for new customers	4.29	4.00	4.15	.667
Adapt some production lines	4.36	4.08	4.23	.734
Change some production lines	3.86	3.42	3.65	.383
Incur marketing cost	3.93	3.92	3.92	.630
Convince the public that bamboo is a good material	4.50	4.17	4.35	.455
Follow government policies	4.29	4.00	4.15	.667
Invest financially	4.36	4.17	4.27	.977
Treat products with preservatives	4.37	3.75	4.12	.048

These results help in validating the results shown in **Table 4.3** where there was slight significant evidence that smaller companies are more innovative in product development. This means that size of company is an important attribute in the adoption of bamboo.

One can conclude that, smaller companies are more innovative with respect to their willingness to train new managers. They are also more ready to develop new products and ensure their durability. Larger companies are less willing to engage in these activities. As larger companies are more endowed with resources, they probably already have qualified managers who need little training. Their low-level of willingness to develop new products could mean that they are already content with what they have and may not need to process bamboo or invest in treatment equipment. This may imply that companies with greater financial resources are able to procure raw material through the Timber Utilization Contract (TUC) bidding system and may not be interested in adopting bamboo. There is no significant difference in the means of all other variables with respect to small and large companies. This implies that both large and small-sized companies are ready to undertake these activities to the same degree; the companies exhibit the same level of innovativeness with respect to these survey items. For example, small and large companies have the same level of willingness to acquire more land, establish their own plantations and purchase and install new processing equipment.

Table 4.7 shows the mean and the p-values for companies that have narrow and broad product profiles. There is no significant difference in the means for companies in these categories. This could mean that the decision to adopt bamboo is not dependent on the product range of the companies. Larger product range does not indicate higher possibility to adopt bamboo.

Table 4.7: Mean Comparison of Innovativeness with Product Profile (Survey Items)

Survey Item	Means for product profiles (N=26)			p-value
	Narrow (N=15)	Broad (N=11)	Total N=26	
Company may have to Acquire more land	3.80	3.64	3.73	.484
Manage own plantation	3.60	3.91	3.73	.524
Install new equipment	3.93	4.00	3.96	.838
Train new managers	3.80	4.18	3.96	.372
Develop new products	4.13	4.09	4.12	.439
Do more research about bamboo	4.00	4.36	4.15	.247
Buy new harvesting equipment	3.87	3.91	3.88	.613
Convince customers to buy bamboo products	4.13	4.36	4.23	.711
Look for new customers	4.07	4.27	4.15	.772
Adapt some production lines	4.13	4.36	4.23	.711
Change some production lines	3.73	3.55	3.65	.712
Incur marketing cost	3.93	3.91	3.92	.627
Convince the public that bamboo is a good material	4.20	4.55	4.35	.505
Follow government policies	4.13	4.18	4.15	.862
Invest financially	4.20	4.36	4.27	.932
Treat products with preservatives	4.00	4.27	4.12	.557

Table 4.8 shows the mean comparison of innovativeness (survey items) with location of company. Data were gathered from four regions but the small sample size restricts regional analysis on the basis of the four regions. Instead, since half the respondents are from the Ashanti region, the region is compared with respondents from the three other regions.

Table 4.8: Mean Comparison of Innovativeness with Location (Survey Items)

Survey Item	Means for location (N=26)			p-value
	Ashanti Region (N=13)	Other Regions (N=13)	Total N=26	
Company may have to Acquire more land	4.23	3.23	3.73	<.01
Manage own plantation	3.92	3.54	3.73	.176
Install new equipment	3.92	4.00	3.96	.420
Train new managers	4.08	3.85	3.96	.488
Develop new products	4.46	3.77	4.12	.016
Do more research about bamboo	4.23	4.08	4.15	.797
Buy new harvesting equipment	4.08	3.69	3.88	.472
Convince customers to buy bamboo products	4.23	4.23	4.23	.463
Look for new customers	4.46	3.85	4.15	.086
Adapt some production lines	4.46	4.00	4.23	.225
Change some production lines	3.77	3.54	3.65	.575
Incur marketing cost	4.23	3.62	3.92	.085
Convince the public that bamboo is a good material	4.31	4.38	4.35	.316
Follow government policies	4.46	4.00	4.23	.086
Invest financially	4.54	4.00	4.27	.128
Treat products with preservatives	4.38	3.85	4.12	.104

There is a significant difference in the mean responses of companies in the Ashanti region and other regions with respect to their readiness to acquire more land. Companies in the Ashanti region are more willing to buy more land than companies in other regions, ($p < 0.01$) and means 4.23 and 3.23 respectively. This indicates that location of company is an important attribute in the adoption of bamboo. There are two possible reasons for this. Since Kumasi where most of

these companies are located in a metropolitan city, it is obvious that land is scarce due to housing and other development activities and companies may have to acquire land outside the metropolitan area. Cities in other regions are less populated and located in or near dense forest or farming areas where land can be purchased more easily. Alternatively, companies in the Kumasi area are more innovative and willing to venture into bamboo processing so they are willing and have more resources to buy more land.

There is also a significant difference in the means of responses of companies in the Ashanti region and other regions with respect to their readiness to develop new products, ($p=0.016$) and means 4.46 and 3.77 respectively. Thus, companies in the Ashanti region are more innovative in new product development. There is also some evidence that the Ashanti region is more innovative than other regions e.g., companies in this region are more ready to look for new customers ($p=0.086$) or follow government policies ($p=0.086$) or incur marketing cost ($p=0.085$). These findings support the finding in **Table 4.4** that companies in the Ashanti region are more ready to engage in process innovation.

Results have been presented on the innovativeness of firms based on their ability to overcome certain predetermined encumbrances. There is some evidence about which firms might be more innovative. In the next section, analysis on the data collected on the availability of resources to the industry is presented. These resources are perceived as barriers or needs if they are non-existent or exist only to a small degree.

Resource Availability – Needs of Companies

The discussion about resources that are perceived to be important to the industry in the bamboo adoption process is presented (see **Figure 4.2**). These are ranked with their degree of importance. The extent to which the resources are available to the firms is an indication of how

much has to be provided in order to ensure adoption of bamboo. The variables are normally distributed and have similar standard errors. One-Way ANOVA (analogous to the t-test) is used to compare the means in this section. On a five-point numeric scale, 1 means “extremely not available” and 5 “available in abundance.” The factor that appears to be most available is land. This implies that, of all the resources, land is the least important need of the companies but it is only available to a small degree.

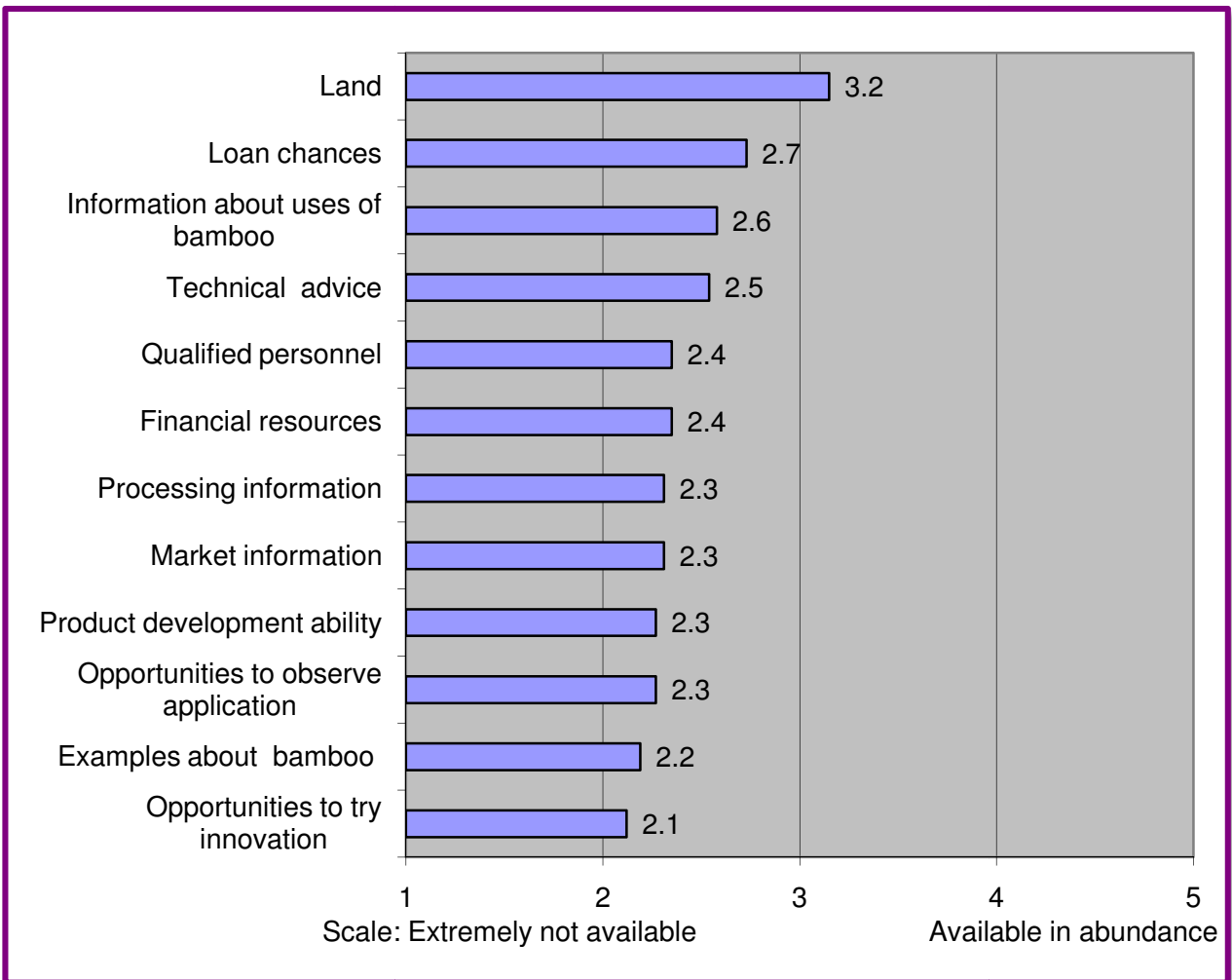


Figure 4.2: Measure of Importance of Availability of Resources (Survey Items)

The item that is least available is “opportunities to try the innovation.” This appears to be the most important need of the companies. In general, the industry lacks resources such as land, chances of loan acquisition, information about uses of bamboo and technical advice. The industry also lacks qualified personnel, financial resources, processing information, market information and product development capability. These must be provided by the government to foster adoption of bamboo in the industry.

Variable Analysis for Resources

As the small sample size did not allow for factor analysis to determine how the factors are grouped and their importance, the survey items with similar meaning were categorized into variables to consolidate the results and define clear areas of needs. The resulting needs or resources to be provided are capital, information, skill/expertise and exposure. Survey items that were considered as capital related are the availability of land, opportunities to procure loans, and the availability of financial resources. Items that were considered as information related are the availability of information about the uses of bamboo, the availability of technical advice, and the availability of processing and market information. For skill/expertise, the relevant survey items are the availability of qualified personnel and product development capability. Opportunities to observe the application of the innovation, examples about bamboo products and the opportunities to try the innovation are the relevant survey items considered as exposure related.

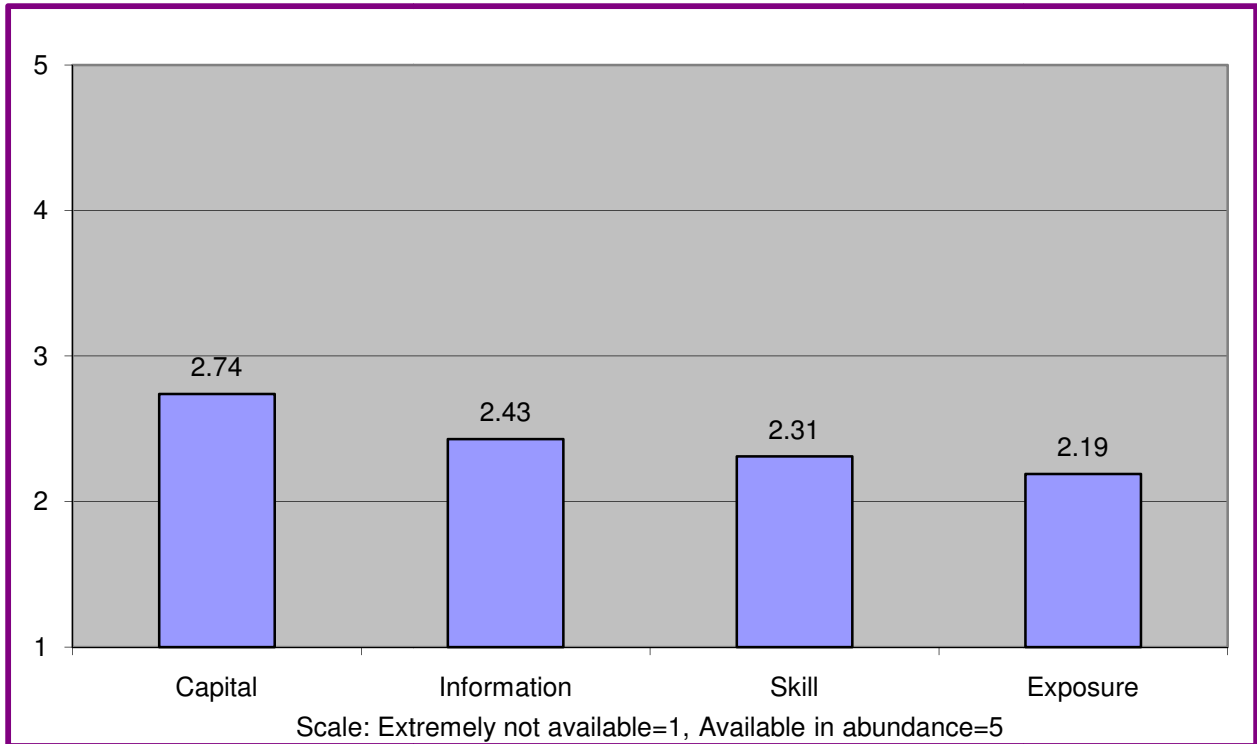


Figure 4.3: Measure of Importance of Availability of Resources (Variable Items)

Capital is the most available resource although it is only slightly available (mean=2.74) on a five-point scale (**Figure 4.3**). This is followed by information (mean=2.43), skill (2.31) and exposure (2.19) as needs. A comparison the responses indicates that there is no significant difference between small and large companies with respect to the resources that are available to them as evident in their p-values (**Table 4.9**). Both sizes of companies lack or need resources and they have to be provided by the government. However, there is a small but significant difference ($p=0.064$) in the availability of capital to small and large companies. Larger companies appear to be more endowed with capital than smaller companies.

Table 4.9: Mean Comparison of Availability of Resources with Size (Variable Items)

Variable	Size	N	Mean	Std. Deviation	p-value
Availability of capital	Small	14	2.45	.76914	.064
	Large	12	3.08	.88905	
	Total	26	2.74	.87080	
Availability of information	Small	14	2.35	.81874	.657
	Large	12	2.52	1.03605	
	Total	26	2.43	.90983	
Availability of skill	Small	14	2.35	.79490	.778
	Large	12	2.25	1.11803	
	Total	26	2.30	.93890	
Availability of exposure	Small	14	2.21	1.00092	.908
	Large	12	2.16	1.06837	
	Total	26	2.19	1.01181	

A comparison of companies in the Ashanti region with those in other regions indicates that there is no significant difference with respect to the resources that are available to them (**Table 4.10**).

Both groups of companies lack resources. Meanwhile, with a p-value of .099, there is a very slight significant difference in the capital resource available to each group of companies.

Companies in other regions appear to be more endowed with capital resources. To help substantiate the results through cross validation, an analysis of the survey items is also presented.

Table 4.10: Mean Comparison of Availability of Resources with Location

Variable	Location	N	Mean	Std. Deviation	p-value
Availability of capital	Ashanti Region	13	2.46	.84479	.099
	Other Regions	13	3.02	.83291	
	Total	26	2.74	.87080	
Availability of information	Ashanti Region	13	2.57	.86834	.430
	Other Regions	13	2.28	.96202	
	Total	26	2.43	.90983	
Availability of skill	Ashanti Region	13	2.42	1.03775	.542
	Other Regions	13	2.19	.85485	
	Total	26	2.30	.93890	
Availability of exposure	Ashanti Region	13	2.25	1.12344	.754
	Other Regions	13	2.12	.92834	
	Total	26	2.19	1.01181	

Survey Item Analysis for Resources

The mean responses indicate that there is no significant difference between small and large companies with respect to the resources available (**Table 4.11**). Mills at both locations need resources as an equal level. However, the ability of companies to acquire loans appears to slightly favor large companies ($p=0.064$), the lowest p-value. It is possible that smaller companies are finding it more difficult to procure loans. This substantiates the earlier findings which show there is better capital capability for larger companies than smaller companies.

Table 4.11: Mean Comparison of Availability of Resources with Size (Survey Items)

Survey Item	Means for size (N=26)			p-value
	Small (N=14)	Large (N=12)	Total N=26	
Land	2.86	3.50	3.15	.222
Technical advice	2.36	2.75	2.54	.376
Market information	2.21	2.42	2.31	.634
Product development capability	2.14	2.42	2.27	.499
Examples to show industry how bamboo is being used	2.43	1.92	2.19	.243
Opportunities for company to try innovation	2.21	2.00	2.12	.670
Opportunities for company to observe innovation application	2.00	2.58	2.27	.278
Qualified personnel	2.57	2.08	2.35	.281
Financial resources	2.14	2.58	2.35	.332
Information about uses of bamboo	2.57	2.58	2.58	.981
Information about bamboo processing	2.29	2.33	2.31	.924
Opportunities to acquire loans	2.36	3.17	2.73	.064

Table 4.12 shows the mean responses of companies with product profile. There is no significant difference between the means of companies with narrow product profiles and those with broad product profiles. Both company groups lack resources to a similar degree.

Table 4.12: Mean Comparison of Availability of Resources with Product Profile (Survey Items)

Survey Item	Means for product profile (N=26)			p-value
	Narrow (N=15)	Broad (N=11)	Total N=26	
Land	3.07	3.27	3.15	.702
Technical advice	2.47	2.64	2.54	.707
Market information	2.33	2.27	2.31	.888
Product development capability	2.20	2.36	2.27	.690
Examples to show industry how bamboo is being used	2.33	2.00	2.19	.455
Opportunities for company to try innovation	2.07	2.18	2.12	.821
Opportunities for company to observe innovation application	2.20	2.36	2.27	.766
Qualified personnel	2.27	2.45	2.35	.684
Financial resources	2.33	2.36	2.35	.948
Information about uses of bamboo	2.87	2.18	2.58	.156
Information about bamboo processing	2.47	2.09	2.31	.451
Opportunities to acquire loans	2.67	2.82	2.73	.740

Table 4.13 shows the importance of availability of resources with respect to location of company. There is a significant difference in the availability of resources with respect to location of companies. This implies that in answering research question 2, location of company is an important attribute in the adoption of bamboo. With a mean of 3.69 and $p=0.034$, companies in other regions have more land than companies in the Ashanti region (mean=2.62). This supports the observation earlier that companies studied in the Ashanti region appear to be more constrained in capital availability. Many companies in other regions are located where land is available. All other resources are lacking to the same extent with respect to company location as there is no significant difference in the means. This implies that companies located in Ashanti and other regions need technical advice, market information and all other resources to a similar degree.

Table 4.13: Mean Comparison of Availability of Resources with Location (Survey Items)

Survey Item	Means for location (N=26)			p-value
	Ashanti (N=13)	Others (N=13)	Total N=26	
Land	2.62	3.69	3.15	.034
Technical advice	2.85	2.23	2.54	.159
Market information	2.54	2.08	2.31	.271
Product development capability	2.38	2.15	2.27	.568
Examples to show industry how bamboo is being used	2.38	2.00	2.19	.382
Opportunities for company to try innovation	2.23	2.00	2.12	.646
Opportunities for company to observe innovation application	2.15	2.38	2.27	.670
Qualified personnel	2.46	2.23	2.35	.612
Financial resources	2.23	2.46	2.35	.612
Information about uses of bamboo	2.77	2.38	2.58	.427
Information about bamboo processing	2.15	2.46	2.31	.533
Opportunities to acquire loans	2.54	2.92	2.73	.390

In the next section, the innovativeness and perceived barriers for individual companies are presented. This will help to further determine the number of companies that are willing to accept bamboo technology.

Importance of Individual Company Responses and Innovativeness

The mean values for each company were calculated to determine their individual degree of innovativeness/receptiveness and asset possession. The means for innovativeness/receptiveness were calculated by dividing each company's sum of responses to the questions that sought to determine their readiness to overcome predetermined barriers (i.e. traits of innovativeness shown in **Figure 4.1**) by the number of questions. This helps to determine whether the industry will adopt, i.e., addressing part of research question 2. **Figure 4.4** shows a measure of the innovativeness for individual respondents. Out of 26 companies, 20 have an innovativeness/receptiveness score of 4 or more on a five-point scale. This implies that it is

possible or perhaps likely that these companies could acquire more land, manage their bamboo own plantation, install new equipment, train new managers, develop new products and do more research about bamboo. These companies may be ready to undertake any investment activities to adopt bamboo.

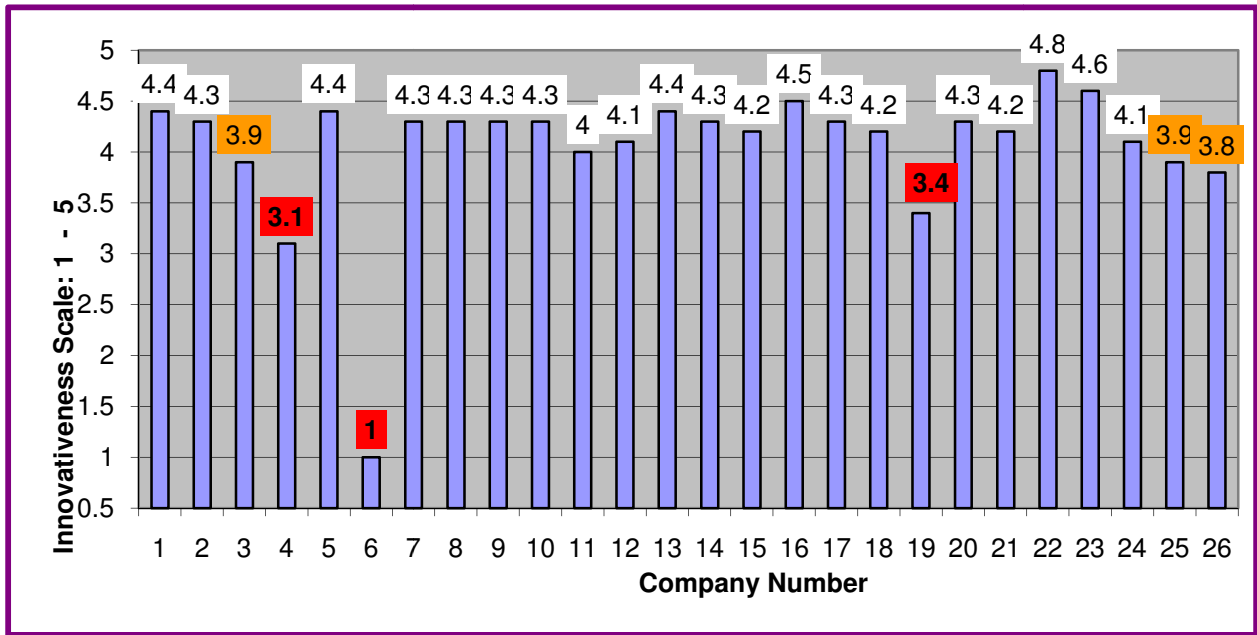


Figure 4.4: Score of Innovativeness for Individual Respondents

Companies may buy new harvesting equipment, convince customers to buy bamboo products, look for new customers, adapt some production lines to use bamboo and change some production lines to process bamboo. Companies may also be ready to incur marketing cost, follow government policies, invest financially and ensure the durability of products. Three companies have scores of 3.8, 3.9 and 3.9. These are also high scores which indicate that it is possible for these companies to be innovative or receptive to bamboo utilization. It is clear that 23 companies or 88% may be ready to adopt bamboo as a raw material in the industry. Two companies scored 3.1 and 3.4 respectively, which are scores above the neutral point. There is

only one company that showed an overwhelming negative response. It is highly unlikely that this company would adopt bamboo.

Due to the small sample size of this study, respondents were classified only into two categories (early adopters and late adopters). Nevertheless, it is important to remember that this study is an acceptability study where there has not been any previous adoption on which future studies can be based. This may make it difficult to apply Rogers' principle which accounts for adoption time. On this basis, it is more appropriate to consider adopters as receptors to the idea of bamboo utilization in this case.

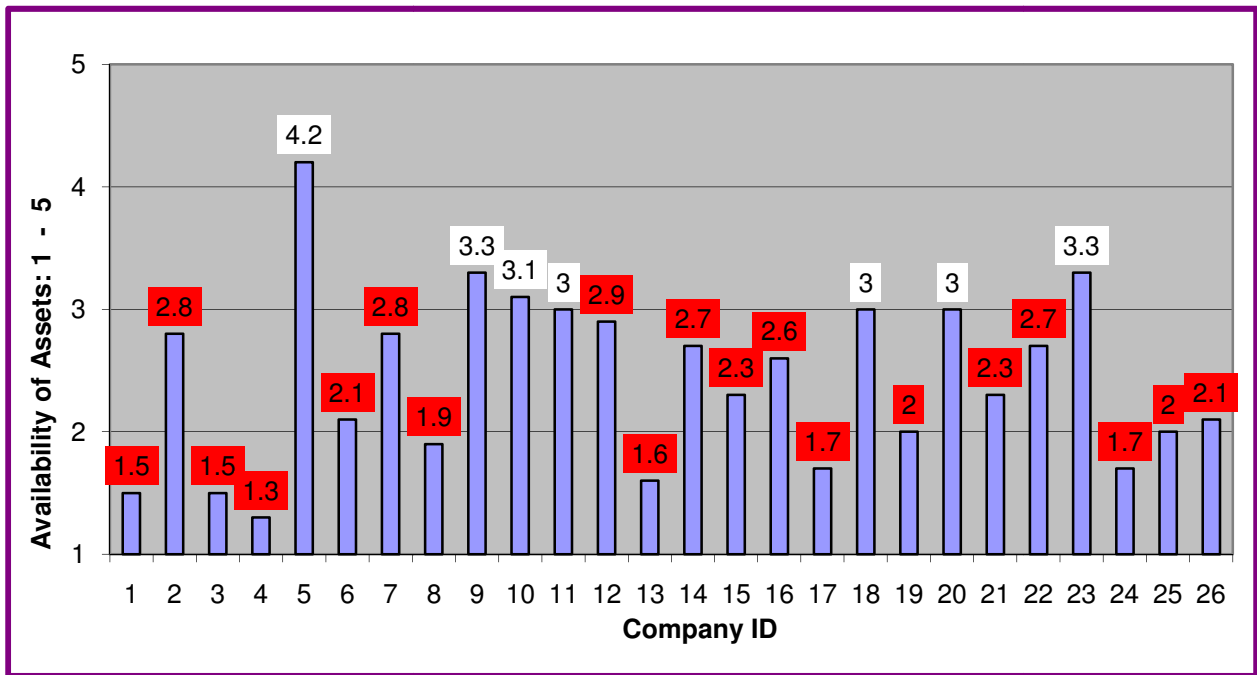


Figure 4.5: Availability of Assets-Individual Responses

Twenty five companies have scores above the neutral point. So these may be ready to accept bamboo as a new raw material. One company with a mean score of 1, which appears to be uninterested in adopting bamboo, may not adopt in the future or will be the last to adopt.

Resource availability is important to individual companies. Nineteen companies (73%) score less than 3.0 which is an indication of lack of resources in the industry (Figure 4.5). Three

companies lie in the middle (moderate availability of resources) and four companies (15%) score above 3.0.

Table 4.14: Responses to ‘yes’ or ‘no’ Discrete Questions (N=26)

Survey Item	Response	Frequency	Percent
Do you know about bamboo as a raw material in the wood industry?	Yes	17	65.4
	No	9	34.6
Do you know any companies that use bamboo in Ghana?	Yes	11	42.3
	No	15	57.7
Do you realize that the wood raw material base is declining?	Yes	26	100
	No	0	0
Do you think that an alternative natural fiber to wood as a raw material is necessary?	Yes	25	96.2
	No	1	3.8
Given your current situation, can you adopt bamboo as a raw material?	Yes	6	23.1
	No	20	76.9
Assuming there are limited barriers, would your company adopt bamboo as a raw material?	Yes	23	88.5
	No	3	11.5

Only one company appears to have adequate resources to adopt bamboo with a score of 4.2 on the five-point scale. The general indication is that, resources are inadequate in the industry and adoption of bamboo would warrant supply of these resources to circumvent the imminent barriers.

The results obtained for short answer open-ended questions indicate that 88% i.e., 23 companies are ready to adopt bamboo provided there are limited barriers (**Table 4.4**). Six companies are ready to adopt bamboo in the current situation. These six companies are considered the early adopters. The remaining 17 can be considered late adopters provided the

three companies that have no interest do not adopt in the future. If these companies decide to adopt in the future, then the total late adopters will increase to 20.

A Chi² analysis shown in **Table 4.15** (p=1 for location and p=.802 for size) using Yates' correction due to the small cell count shows that, for the six companies, adoption is not dependent on size or location of company. This indicates that the decision of companies to adopt bamboo is not related to their location or size. A binomial test (p<0.01) shows that the difference in the number of companies which are ready to adopt bamboo in the current situation (n=6) and those that are not ready (n=20) at a test proportion of 0.5 is significantly more than 50%.

Table 4.15: Statistical Inferences with Respect to Adoption in Current Situation

Company Attribute	Chi ² (Yates' correction) (p-value)	Binomial test (p-value)
Size	.802	
Location	1.0	
Adopters in current situation		.009

Some companies are currently capable of adopting bamboo while others will adopt only if barriers are removed. The following section provides the reasons for respondents' decisions.

Reasons why Some Companies will or will not Adopt Bamboo

Respondents were asked why they will or will not adopt bamboo in their current situation which is full of barriers. They were also asked to state why they will or will not adopt bamboo in the event that barriers are removed or if only limited barriers exist. The next section discusses the responses to these questions.

Reasons why Companies will Adopt Bamboo in Current Situation

Some companies are willing to adopt bamboo in the current situation because they know that the supply of wood raw material is dwindling. Some of the respondents said they are well equipped and can try using bamboo. One company has already tried processing some bamboo products. Other companies process surplus wood into value-added products and can do the same with bamboo. Some companies have adequate knowledge about wood processing and may need little training to use bamboo. Looking at the reasons why companies are capable of adopting bamboo in the current situation, one could interpret this to mean that these companies are innovative.

Reasons why Companies will not Adopt Bamboo in Current Situation

The reasons why companies cannot adopt bamboo in the current situation include lack of information on markets, products and machines. Some respondents attribute their position to lack of expertise e.g., there is no technological know-how and no knowledge about bamboo. One company is almost closed down due to raw material shortage. Few companies are not ready to adopt bamboo at all because they are leading lumber exporters in the country and they have their own timber plantations and concessions procured through the timber utilization contracts (TUC). Their competitive advantage is in lumber production. To some companies, the bamboo raw material is not available. To others, existing machines are not designed to process bamboo. Some companies, referred to as late adopters, are willing to adopt given limited barriers. The reasons for their decision follow.

Reasons why Companies will Adopt Bamboo Given Limited Barriers

Table 4.14 shows the frequency and percentage distribution of companies that are willing to adopt bamboo given limited barriers. When barriers are removed, 88% of respondents are willing to invest in a bamboo business. The companies' reasons for making such choices are cheaper raw material, low cost of extraction, and opportunity to remain in business. Others would adopt bamboo because it is possible for their companies. Some companies see adoption of bamboo as away to reduce pressure on threatened timber species.

Reasons why Company will not Adopt Bamboo Given Limited Barriers

Table 4.16 shows the frequency and percentage distribution of companies that are willing to adopt or not adopt bamboo given limited barriers.

Table 4.16: Frequency Distribution of why Companies will or will not Adopt Bamboo Given Limited Barriers (N=26)

Why will company adopt or not adopt bamboo given limited barriers?		
Response	Frequency	Percent
Will adopt because it's cheaper	2	7.7
Will adopt in order to survive	21	80.8
Will NOT adopt because company has adequate wood raw material and/or company is a leading lumber exporter	2	7.7
Will NOT adopt because company cannot afford	1	3.8
Total	26	100.0

Two companies are not ready to invest in bamboo because they have adequate wood raw material. Another company is not willing to invest because of inadequate financial resources.

Identifying Factors that Facilitate Adoption

One of the goals of this study is to determine the best way to remove barriers to the adoption of bamboo in Ghana's forest products industry. To accomplish this, respondents were canvassed regarding their level of awareness about bamboo utilization and their perceptions about the use of bamboo. These issues are explored in the next section. Some of the findings are synthesized with other results to develop the models for adoption presented in Chapter 6. The results in **Table 4.14** also help in cross validating other findings of the study.

Canvassing CEOs' Awareness about Bamboo Utilization

The study was started with an introduction to determine how much knowledge the respondents have regarding the current status of the forest products industry and about bamboo. This objective was met with some short answer open-ended questions. **Table 4.14** shows the responses to these questions.

Asked whether they know about bamboo as a raw material in the industry, 65.4% of the respondents said yes. Some of them referred to furniture companies and small-scale bamboo manufacturers as the current users of bamboo. This is an indication that more than half the industry knows about bamboo as a raw material. Fifty eight percent of all respondents do not know any companies that use bamboo in Ghana. All respondents (100%) realize that the wood raw material is declining and 96.2% supports the initiative to supplement wood with an alternative natural fiber material. In their current situation which is inundated with barriers to adoption, about 77% of respondents said they would not be able to adopt bamboo.

To understand how useful bamboo could be, they were asked to determine the products that they believe can be made from bamboo. This supposedly helps to know to some extent the degree to which mills are aware of the importance of bamboo (**Table 4.17**).

Table 4.17: Products Respondents Think can be made from Bamboo

Product	Response	Frequency	Percent
Plywood	Yes	13	50
	Do not know	13	50
Particleboard	Yes	13	50
	Do not know	13	50
Block board	Yes	13	50
	Do not know	13	50
Flooring	Yes	19	73.1
	Do not know	7	26.9
Molding	Yes	16	61.5
	Do not know	10	38.5
Broomsticks	Yes	14	53.8
	Do not know	12	46.2
Windows	Yes	13	50
	Do not know	13	50
Doors	Yes	14	53.8
	Do not know	12	46.2
Handicrafts	Yes	18	69.2
	Do not know	8	30.8
Dowels	Yes	6	76.9
	Do not know	20	23.1
Furniture	Yes	22	84.6
	Do not know	4	15.4
Profile boards	Yes	11	42.3
	Do not know	15	57.7

Products that greater than 50% of companies believe can be produced from bamboo in decreasing order are furniture, dowels, flooring, handicrafts, molding, broomsticks and doors. Half of the respondents believe that bamboo can be used for products such as plywood, particle board, block board and windows. The product for which respondents were most uncertain is profile boards. About 58% have no idea whether profile boards can be made from bamboo. As observed in Chapter 3, many of the companies canvassed that manufacture moldings, floorings

and plywood believe that bamboo can be used for these products. The government is urged to use this opportunity to promote the use of bamboo.

As gathered from literature and observation, all the products listed in **Table 4.17** can be produced from bamboo. This raises the question about respondents' awareness about the uses and importance of bamboo. It seems that respondents do not have adequate information about the uses of bamboo. Most of their responses are based on the premise that they have seen bamboo products. Other products that can be produced from bamboo include toys, carvings, cutlery, table tops and tongue-and-groove. When asked where they learned about the use of bamboo as a raw material, some said they saw products with other people, e.g., furniture in people's homes, from literature and from petty traders. Other sources include the Forestry Research Institute (FORIG), the Forestry Commission, the media/TV, the industry, and trade fairs. Respondents named companies that manufacture bamboo products including Pioneer Company located in Assin Fosu, Kumasi Logging & Lumber Company (KLL) located in Kumasi, furniture companies and AFWEL Company located in Accra. Products that these companies produce from bamboo are furniture (tables & chairs), doors, flooring, toothpicks, flower vases, parquet and curtains.

Canvassing CEOs' Awareness about Cost Benefits of Bamboo Utilization

One of the perceived attributes of innovation, relative advantage, was used to determine respondents' perception about the cost benefits of bamboo utilization in contrast with wood. Respondents were asked to compare bamboo and wood on a paired comparison scale in terms of cost. Companies perceive costs associated with bamboo to be wood be higher than wood (**Table 4.18**). Some respondents could not determine which material usage (wood or bamboo) is associated with higher costs. Some believe that the costs are the same for both bamboo and wood.

Table 4.18: Qualitative Comparison of Cost between Bamboo and Wood

Item	Response	Frequency	Percent
Cost of land	Do not know	12	46.2
	Cost higher for wood	9	34.6
	Cost higher for bamboo	4	15.4
	Same cost	1	3.8
Plantation management cost	Do not know	13	50.0
	Cost higher for wood	9	34.6
	Cost higher for bamboo	3	11.5
	Same cost	1	3.8
Harvesting cost	Do not know	13	50.0
	Cost higher for wood	12	46.2
	Cost higher for bamboo	1	3.8
Hauling cost	Do not know	13	50.0
	Cost higher for wood	10	38.5
	Cost higher for bamboo	2	7.7
	Same cost	1	3.8
Handling cost	Do not know	12	46.2
	Cost higher for wood	11	42.3
	Cost higher for bamboo	3	11.5
Inventory cost	Do not know	14	53.8
	Cost higher for wood	6	23.1
	Cost higher for bamboo	6	23.1
Processing cost	Do not know	15	57.7
	Cost higher for wood	6	23.1
	Cost higher for bamboo	5	19.2
Marketing cost	Do not know	16	61.5
	Cost higher for wood	1	3.8
	Cost higher for bamboo	8	30.8
	Same cost	1	3.8
Production management cost	Do not know	15	57.7
	Cost higher for wood	5	19.2
	Cost higher for bamboo	6	23.1
Capital cost	Do not know	17	65.4
	Cost higher for wood	6	23.1
	Cost higher for bamboo	2	7.7
	Same cost	1	3.8
Raw material cost	Do not know	14	53.8
	Cost higher for wood	12	46.2

Although the respondents have not used bamboo, their perception about the cost implications of using bamboo can encourage them to seek further information about the venture. Many companies seem to have little knowledge about bamboo raw material costs. However, a sizeable number of respondents determined that bamboo usage is associated with a much lower cost than wood. This result may be flawed with bias. However, it gives some indication about respondents' cost perception about bamboo in contrast with wood.

For instance, apart from the 53.8% of companies that do not know which raw material is more expensive, the remaining 46.2% believe that raw material cost is higher for wood versus bamboo. Apart from marketing costs which 31% of respondents perceive to be higher for bamboo, all other costs are perceived by respondents to be higher for wood. This is a positive indication that, companies at least perfunctorily, consider bamboo utilization to be associated with several cost advantages. When encouraged by the government, they may be interested to adopt bamboo.

Open-ended Questions for Industry

Open-ended questions posed to respondents sought their perceptions of barriers to the adoption of bamboo and the needs that would facilitate adoption. Suggestions for new policies such as bamboo plantation management, processing and marketing of bamboo and bamboo products were also elicited.

Barriers Perceived by Industry CEOs to Adoption of Bamboo

Surveyed managers identified several barriers that may inhibit the rate of adoption of bamboo in the industry. They include lack of information, high investment cost, lack of markets, low raw material base and poor quality, and poor perception about bamboo (**Table 4.19**).

Table 4.19: Frequency Distribution of Major Barriers Perceived by CEOs (N=26)

Major barrier faced by company	Number of Respondents who mentioned this barrier	Percent
No information on product, machines, cost, markets, raw material etc.	17	65.4
No technological know-how	16	61.5
High investment capital	11	42.3
Low raw material base	9	34.6
No equipment	7	26.9
No markets	5	19.2
Poor perception about bamboo	5	19.2
Uncertainty	5	19.2
No land	4	15.4
Company has adequate wood raw material or not ready	3	11.5

Lack of Markets

As shown in **Table 4.19**, 19.2% of respondents expressed concerns about a possible lack of markets for bamboo products. Some respondents are not sure whether markets exist and whether good prices will be offered for bamboo products. Other respondents thought that there might be little demand for bamboo products. Many respondents (65.4%) expressed worries about lack of market information. They virtually have no information about the importance of bamboo products, or the markets where they can sell their products with good prices. Some respondents know about China as a market leader of bamboo products have the sentiments that Ghana cannot compete in the global market. Many felt that marketing cost would be high for bamboo products.

Lack of Information

The barrier mentioned most, i.e., 65.4% of respondents, is lack of information about bamboo (products, machines, cost, markets, and raw material). Some companies seemed to have no idea that bamboo is a useful raw material. Most have no information about current stocking of bamboo in Ghana. Some companies have no idea where to start from and are not sure about the results of venturing into bamboo processing. They believed that bamboo will be difficult to process and handle and that adequate information is lacking on the use of bamboo. Most companies (61.5%) deplored their lack of technical know-how about bamboo utilization. They had no knowledge about the mechanical properties of bamboo, no knowledge about its processing, and no information about saw doctoring, processing, drying and grading of bamboo products. Some of the respondents were pessimistic about their global performance as they lack the necessary expertise. Others believed that the country seems not technologically ready for bamboo processing.

High Investment Cost and Lack of Processing Equipment

About 42% of respondents perceive that the initial investment cost to be high. For example, capital for acquiring manufacturing equipment and related machinery is expected to be high. They also perceive high training costs in helping employees acclimatize to the change in raw material handling and processing. Some companies fear that insufficiency of logistics would make it difficult for them to adopt bamboo. They lack adequate finances to undertake technical and processing training. Nineteen percent of companies are risk averse and fear the consequences of venturing into bamboo manufacturing, a new venture with little available information. Lack of land appropriate for bamboo plantations is a worry among for 15.4% of respondents who saw this as unwanted cost necessary for bamboo processing.

Approximately 27% of respondents indicated that they do not have equipment that can process bamboo, which implies that they have to acquire and install new machines. They see this as a financial burden and a deterrent to bamboo investment. They also expressed concerns about the lack of information on the equipment appropriate for bamboo plantation management, harvesting and processing.

Low Raw Material Base, Poor Quality and Perception

Ghana currently has some standing volume of bamboo. However, 34.6% of respondents perceive this to be in small quantities that cannot adequately furnish the whole industry for commercial use. The standing volumes are being harvested by small-scale handicraft manufacturers and the rate of harvest has been described by some respondents as unsustainable. A leading bamboo processing company faces acute raw material shortages because of its location is a great distance from the raw material source and faces high transportation costs. Another negative factor is the inappropriateness of the dominant bamboo species in Ghana (*Bambusa vulgaris*) for many uses. The species is susceptible to insect attack, especially termites, and needs improvement to meet commercial standards.

Existing bamboo plantations are not well managed so stands cannot produce straight poles needed in manufacturing leading to raw material shortage. Knowing this, wood processing companies think that the existing unmanaged plantations cannot adequately supply the needed raw material.

Nineteen percent of respondents have worried that there is poor perception about bamboo in Ghana. Bamboo has generally been used for noncommercial products and appropriately for fencing, ceilings in thatched buildings and cottage siding. There is a stigma associated with bamboo and its use means it will be difficult to convince consumers that bamboo is similar to

wood. In their opinion, changing customer attitudes towards bamboo is difficult and will take a long time to change.

Lack of Government Support and Unavailability of Research Results to Companies

Some respondents expressed disappointment at the government's poor support for growth in the forest products industry. They believe that the adoption of bamboo could only be successful if the government provides the resources to facilitate adoption of bamboo.

Some companies expressed dissatisfaction at the lack of bamboo related research results. They noted the unwillingness of researchers to make results publicly accessible and the industry know little about their findings. There were also complaints about some researchers and institutional heads who have traveled to China and other countries to learn about bamboo but have done very little to convey the information learned to the industry in Ghana.

Availability of Adequate Wood Raw Material in Some Companies

About 12% of companies have adequate wood raw material through their own afforestation and plantation programs and hence do not need bamboo to supplement their resource base. Some of these also contend that they have large acreages of concessions from the government and thus are not interested in bamboo. One company is a leading exporter of lumber made from wood and sees the use of bamboo as a barrier to its market positioning. Some companies are simply not prepared to use bamboo as a raw material.

Needs Perceived by Industry CEOs for Adoption of Bamboo

The major needs perceived by respondents that would help them to successfully adopt bamboo are listed in **Table 4.20**. The needs are capital, information, technical support, training, long-term finance, markets, raw material, education/awareness creation and appropriate land.

Capital

The need mentioned most by respondents (53.8%) was capital. Many companies lack capital in the form of finances to invest in the new venture. Capital is needed to acquire the necessary equipment and train workers to effectively implement the change. Capital in the form of land is also a big need for plantation establishment. Even if there is adequate capital but information and technical support are lacking, firms may refrain from adoption.

Table 4.20: Frequency Distribution of Major Needs Perceived by CEOs (N=26)

Need of company	Number of Respondents who mentioned this need	Percent
Capital	14	53.8
Information about bamboo	14	53.8
Technical support	12	46.2
Training	11	42.3
Long-term finance	8	30.8
Markets	6	23.1
Raw material	6	23.1
Education/awareness	4	15.4
Appropriate land	2	7.7

Information and Technical Support

Information about bamboo is another need mentioned by 53.8% of respondents. Respondents want more information on the machines used for processing bamboo, their maintenance needs, where to acquire them, and how they are operated. They also need information about products that can be processed from bamboo, how the processing is done and the technology. Most respondents want information about existing markets, the products that are suited for specific markets and how to market the products. Information is also sought about

plantation management techniques in order to ensure healthy and productive plantation growth. Some companies said a cost benefit analysis would help them evaluate investment options. About 46.2% of respondents expressed the need for technical assistance from institutions. They need extension and technical advice at various stages of the supply chain.

Training

About 42% of respondents advocate training as prerequisite to the adoption of bamboo. Both formal and informal training are deemed important in ensuring the successful adoption of bamboo. Training of employees is needed in plantation management, processing and business management. Training will improve the knowledge base of employees and enrich their expertise. Respondents also advocate training of researchers to equip them with the necessary skills to undertake rigorous research and provide information on the bamboo species to be planted, the type of land on which to grow the species, plantation management, processing, saw doctoring, preservative treatment, management and marketing.

Long-term Finance, Favorable Conditions for Loans and Markets

Approximately 31% of companies are unhappy about the current difficulties in loan acquisition and urge banks to be more flexible with lending conditions. They call for low interest rates and long-term loans. As shown earlier in the comparison of large and small companies, smaller companies are faced with more stringent obstacles in loan acquisition. Markets are needed after capital has been made available in order to sell products and make profit.

Companies, as indicated by (23.1%) of respondents want to see export orders coming from buyers or through the Forestry Commission's Timber Industry Development Division.

They would like to see that markets exist for bamboo products and that they can process and supply high quality products to these markets.

Education/Public Awareness

Fifteen percent of respondents have the notion that public awareness is prerequisite to adoption of bamboo. A number of them have the notion that buyers/importers need to be educated about the importance and benefits of using bamboo. Others are of the view that government officials also need to be educated about the importance of bamboo to ensure its promotion. Some respondents advocate awareness creation that would educate communities, the government, customers and other stakeholders about the need for using bamboo and the advantages in its adoption. Government support is needed to ensure successful implementation of all the necessary policies.

Land and Raw Material

The need least mentioned by respondents (7.7%) is land. As mentioned earlier, however, it does not mean that all other firms do not need land. The bamboo raw material must be available in order to convince companies to engage in its processing. The current standing volume of bamboo raw material must be available in steady supply, or if plantations will be established, they must be capable of adequately furnishing the companies. The quality of the raw material needs to match market demands. Twenty three percent of respondents mentioned sustainable supply of quality raw material as a need. Some companies want useful species to be introduced.

Government Involvement

Government involvement is perceived by some respondents as crucial and an impetus in promoting the adoption of bamboo. Government assistance is needed from all institutional stakeholders such as the Forestry Department, the Forestry Research Institute of Ghana (FORIG), the Ghana Timber Millers' Organization (GTMO), the Ghana Export Promotion Council (GEPC) and universities. Government needs to develop policies for the use of bamboo in the country. Government could be involved in many ways, e.g., through awareness creation, support in the supply of logistics, and policy formulation.

So far, barriers and needs that might impact adoption of bamboo in Ghana's forest products industry as perceived by company CEOs have been identified. In order to clear these barriers and provide the necessary needs to ensure adoption, it is important to formulate policy and instruments and management strategies. Therefore, respondents were canvassed to provide some useful suggestions. The next section dwells on this discussion.

Policy and Management Suggestions from Industry CEOs

Respondents were asked to provide policy suggestions on relevant issues that can foster implementation of bamboo processing businesses.

Research

Respondents have urged researchers to undertake research on local species and determine what needs to be improved. Research institutions are urged by the industry to set up a small pilot plant which will produce a real product and then determine how much it costs to produce 1m³ of the product. Research in all areas is important especially soils, stock survey to determine the current stocking volumes of natural stands, and species that will attract markets. Respondents

also want researchers to provide information for processing, lean manufacturing, quality assurance and the end uses of bamboo. Other outputs anticipated by the industry include information on quality standards of products, guidelines for preservative treatment, input-output volume ratio of products and corresponding income, processing cost, hauling cost, and total cost in comparison with wood.

Government is encouraged to make policies to support research in bamboo and ensure that results are accessible to the industry at no cost. In that regard, the Forestry Research Institute of Ghana (FORIG) is urged to share research results with the public through the Ghana Timber Millers' Organization (GTMO), and conduct seminars, workshops and employ other effective means of communication in order to disseminate information to a wider group of stakeholders. Such an effort will facilitate awareness creation. Workshops should be presented by researchers to inform the industry about relevant machines and manufacturing methods and products. Researchers should join forces with government agencies to visit the industry and present a compelling case for bamboo. Interdisciplinary research is also encouraged. The public relations department of the relevant research institutions should be strengthened in order to help disseminate information about bamboo. A day could be set aside as FORIG publicity day on which farmer groups would be invited to be informed about the importance of bamboo and the benefits in investing in bamboo plantations.

Government should be urged to provide financial support for research. Researchers need laboratory equipment and other logistics. Government should make policy provisions that would mandate financial support to the relevant research institutions. Government is requested to train more scientists who can do research in all aspects of the bamboo supply chain. Some respondents propose that some revenues from forest product sales be set aside for bamboo research. Part of

the levies paid by forest products firms should be used to do research and disseminate research results.

As a government policy, respondents believe that if researchers collaborate with companies that are already growing or producing bamboo, it would help in identification of research needs and gaps. Collaboration between researchers and other institutions and countries such as China which already have some information about bamboo is also suggested.

Marketing Strategies

Respondents want government to include in the functions of certain institutions policies that mandate them to locate markets for bamboo and promote its products. Some of these institutions are the Ghana Export Promotion Council (GEPC), the Ghana Investment Promotion Center (GIPC), the Bamboo and Rattan Development Program (Baradep) and the Timber Industry Development Division (TIDD). Their budgets should support trade and marketing of bamboo. They should develop market strategies that would facilitate marketing and trade of Ghana bamboo products. Other related organizations that promote non-traditional exports are urged to participate in developing policies to promote bamboo. People who are knowledgeable about bamboo and bamboo products and their markets are encouraged to come forward with ideas.

Diffusion of bamboo technology and its promotion can be in the form of radio and TV advertisement and public showcasing to explain to the populace the benefits of buying bamboo products. This will inform local people about bamboo and its uses. Respondents believe that exhibition of bamboo at trade shows would be an effective way to promote bamboo. The prominent Ghana International Furniture and Woodworking Industry Exhibition (GIFEX) which

is held every other year would be a good opportunity to showcase some available bamboo products, processing equipment, brochures and other publications.

As a way of diffusing the adoption of bamboo, some respondents have suggested that government pass a decree that would compel public offices to use bamboo products such as furniture. All institutional buildings such as hospitals and schools that are being built by the government could be furnished with bamboo products. Some parts of these buildings could be built with bamboo panel products. Other businesses such as banks and hotels could use bamboo furniture, flooring and other products as a way of promoting the material. If the government itself shows leadership in using bamboo products, the rest of the public can emulate their example.

A number of respondents encouraged the industry to adopt bamboo and produce attractive and innovative products. Producing quality and competitive products will be very important for market access. Government should develop quality standards that would provide guidelines for grading bamboo products. Since the industry is already more familiar with the European markets, some companies suggest that the government should have dialogues with Europe about how to introduce bamboo products into their markets.

Export and Import Strategies

According to some respondents, if import of bamboo products is encouraged, it would give the industry an opportunity to learn about the products that are globally available and help them to more easily manufacture similar products. Once this is done, companies should be encouraged to test market the products in established local markets before engaging in exports.

Another important factor mentioned by many respondents is the exemption of bamboo products from export tax. Waiving export levy on bamboo products will motivate companies to

engage in the business. Currently, the industry pays 1.5% export tax, a reduction of 50% from the previous 3% on wood products. However, as a non-traditional commodity, bamboo products are not supposed to attract export taxes in Ghana's trade system. Companies urge the government to make imported bamboo related machines tax free. All other imports related to bamboo should not attract tax charges in order to help start the project.

Relevant institutions such as the Timber Industry Development Division (TIDD) and the Ghana Export Promotion Council (GEPC) are entreated to develop export plans for the industry. They are also asked to develop quality standards that meet international standards as it is done for current forest products such as floorings, moldings, plywood and veneer. Government is urged to set prices of products at levels that would bode well for the industry. Importers have to be involved in all discussions relating to the transition to bamboo usage in order to avoid conflicts and promote successful introduction of the new product. Respondents suggest a policy that supports exports to familiar markets such as Europe. Government is also entreated to establish bilateral relations with countries that are already engaged in bamboo trade.

Some respondents advocate protectionism i.e. they have the impression that restriction on imports would compel local consumers to patronize locally made products. They argue that the bamboo products being imported to the country now are cheap and that this may deter consumers from buying locally produced products. Notwithstanding, as some respondents suggested, companies will have the opportunity to familiarize themselves with bamboo products if imports are allowed. The suggestions made by industry CEOs regarding management about bamboo are presented below.

Management

To ensure success, some companies believe that the involvement of district assemblies is important. District assemblies are the local governing bodies that serve between the people and regional and national government authorities. They are headed by District Chief Executives (DCEs) who have much influence on the communities. There are also assembly men who serve as liaison officers between the communities and the district assemblies. The involvement of these entities would help in managing community projects such as bamboo arboretums.

The government is also advised to establish a governing body to promote bamboo use. The Bamboo and Rattan Development Program (BARADEP) which serves under the Forestry Commission is established for this purpose. Government should manage this well and ensure accountability. Funds allocated for bamboo projects should be used accordingly. The government is petitioned to establish plantations and manage them well as has been done for teak plantations.

The government should train more researchers and technical personnel to manage plantations, do research in species, provide guidelines for plantation management and provide harvesting techniques.

Policies

The Ghana government should develop policies toward sustainable raw material production. Plantations are necessary in order to ensure sustained supply of the raw material. Respondents request that government develop strategic plans that will be followed by the forestry department for establishment of plantations. It is required of the government to grant bamboo concessions (if they become available) to companies and tax credits given to bamboo

manufacturers. The government can also enact a policy that mandates timber companies to cultivate and process bamboo in addition to wood.

A policy should be developed for specific areas of the supply chain of bamboo and bamboo products. The government needs to be proactive and enthusiastic about what they say and get the work done. The consequences of policies should be considered before implementing them. Some policies have been detrimental to the industry's growth. For instance, export taxes of forest products were previously high until the industry protested and they were reduced.

It is suggested that the government ensure that research results are made available to the industry and other stakeholders in hardcopies. Results could also be made available at meetings, seminars, workshops and websites. Research results should also be published in scientific journals. Some respondents want communities such as district assemblies to establish plantations. In such cases, there is a stronger community effort in preventing and fighting bushfires. Respondents suggest that a land policy be formulated and implemented to guide in deciding which type of land to be used for plantation management. Policy should be developed for harvesting. With a good land policy respondents expect the government to provide the appropriate land in adequate acreages to interest parties for plantation establishment.

Ghana has bamboo stands which respondents suggested should be used before planting more. Bamboo sometimes becomes invasive so some respondents would like to be sure that the current standing volumes of bamboo are effectively transformed into marketable commercial products before putting more land under cultivation of bamboo.

The government should foster more flexible conditions for loan acquisition. More importantly, government should ensure that banks offer long-term loans with low interest rates to stakeholders. Awareness creation is important. It can be done effectively through community

programs. The public should be given the necessary education. Information about the potentials of bamboo should be made available.

Technical Advice

Respondents want technical information about bamboo, but first, technical personnel must be trained and remunerated well. Once these people are well equipped, they should be mandated to visit companies and provide training through workshops and seminars. This can be done in conjunction with FORIG. In the interviewing process, it was learned that some technical personnel have been sent by the government to China for training; this is helpful. The trainees need to disseminate the information to the relevant stakeholders.

Technical officers should be mandated to provide guidance on the use of equipment, manufacturing process and preservative treatment. They should be able to provide advice on the acquisition of equipment, marketing of products and other relevant assistance needed by stakeholders.

Conclusions

This study was conducted because Ghana's forest resource base has been declining faster than it is being replenished and increased use of bamboo may help slow the rate of deforestation and adequately supply the industry with raw material. The study determined the barriers and needs perceived by the industry to the adoption of bamboo. Policy suggestions were also canvassed from the respondents.

Several barriers were identified in both closed-ended and open-ended questions. Companies were found to be least interested in the requirement to change their current production lines to process bamboo. This can be described as a compatibility barrier which may

slow the diffusion of bamboo adoption. It may be required to buy new equipment at high capital investment. The government is requested to provide adequate financial capital resources for investors to use. Development NGOs and international organizations such as the World Bank, DFID and FAO could help the Ghana government in meeting the Millennium Development Goals by incorporating the commercial utilization of fast growing species like bamboo in their investment projects.

Companies are also not innovative in acquiring more land or growing their own plantations. This implies that community ownership would save companies the trouble of searching for the appropriate land for bamboo plantations. The government should encourage district assemblies to grow bamboo plantations that can be sold to companies. Companies are ready to market bamboo products. In addition, they are more ready to adapt their production lines to process bamboo than changing production lines.

Smaller companies were found to be significantly more ready to train new managers, develop new products and treat products with preservatives. These three survey items are product related and indicate that smaller firms are more innovative in product development. However, larger companies can better afford to procure raw material through the Timber Utilization Contract (TUC) bidding system. Therefore, as it was gathered that smaller companies lack financial resources to a larger extent, they must be granted long-term loans with affordable payback rates to mitigate the constraints to the adoption of bamboo. Banks, the government, INBAR and development NGOs are all urged to assist small and innovative companies.

Respondents in the Ashanti region are more ready than those in other regions to acquire more land and develop new products. The government should ensure that the land tenure system does not constrain companies from acquiring land for new bamboo plantations. Small and large

companies were found to be similar with respect to most of the resources available to them. This indicates that all the companies need support from the government in the supply of resources.

The results indicate that most of the companies are receptive to bamboo adoption. Six companies are willing to adopt bamboo in the current situation and 20 appear to adopt later. Institutions are urged to create awareness about the benefits of using bamboo, and provide training opportunities to the industry. Opportunities to observe bamboo processing should ensure that companies will gain adequate skills regarding plantations, products, processing and markets. These could be provided through awareness creation and training programs.

Companies that are innovative need to be encouraged and exposed to the innovation, e.g., through workshops, seminars and demonstrations. The industry is urged to support research institutions with funding to conduct research. Institutions need to demonstrate to the public that bamboo is a desirable material. In creating this awareness, the government may mandate that institutional offices like district assemblies, hospitals, and schools use bamboo products such as furniture and flooring. Creating awareness is a marketing tool that enhances diffusion and rate of adoption. The Ghana Export Promotion Council and the Timber Industry Development Division should help the industry or innovative companies to identify market channels.

References

Acs, Z. J. and D. B. Audretsch. 1991. Innovation and Technological Change: An Overview, In: Acs, Z. J. and D. B. Audretsch (Eds.), Innovation and Technological Change: An International Comparison. The University of Michigan Press. 208pp.

Afuah, A. 1998. Innovation Management: Strategies, Implementation, and Profits. Oxford University Press, New York. 403pp.

Aldridge, A. and K. Levine. 2001. Surveying the Social World: Principles and Practice in Survey Research. Open University Press. Buckingham, Philadelphia. 196pp.

- Alreck, P. L. and R. B. Settle. 2004. *The Survey Research Handbook*. Richard D. Irwin, Inc. USA. 463pp.
- Bank of Ghana. 2004. *Report on the Timber Industry in Ghana*. Research Department, Sector Study Series. 1(1): 1-33.
- Barrett, J. D. and D. H. Cohen. 1996. *Wood Products Education: The Canadian Strategy for Renewal and Growth*. *Forest Products Journal*. 46(9): 15-20.
- Bowe, S., R. Smith, J. Massey, and E. Hansen. 1999. *A Methodology for Determining Extension Constituent Needs: A Case Analysis in the Forest Products Industry*. *Journal of Extension*. 37(4): 10pp.
- Bratkovich, S. M. and L. E. Miller. 1993. *Perceived Educational Needs of Innovative Ohio Sawmill Operators*. *Forest Products Journal*. 43(3): 35-40.
- Brito, C. and D. Cevallos. 2004. *New Bamboo Furniture*. *INBAR News*. 11(2).
- Brown, T. D. and S. S. Niemiec. 1997. *Survey of the Training Needs in Oregon's Lumber Manufacturing Industry*. *Forest Products Journal*. 47(1): 29-32.
- Cao, X. and E. Hansen. 2006. *Innovation in China's Furniture Industry*. *Forest Products Journal*. 56(11/12): 33-42.
- Chen, C., H. Chen, and T. Liao. 2000. *Bonding Moso Bamboo with Copolymer Resins made of Biomass Residue Extracts with Phenol and Formaldehyde*. *Forest Products Journal*. 50(9): 70-75.
- Crespell, P. and E. Hansen. 2008. *Managing for Innovation: Insights into a Successful Company*. *Forest Products Journal*. 58(9): 6-17.
- Dillman, D. A. 2000. *Mail and Internet Surveys: The Tailored Design Method*. 2nd Edition. John Wiley & Sons, Inc. 464pp.
- Eastin, I. L. 2003. *Toward the more Effective Marketing of Lesser Used Tropical Timber Species: A Theoretical Framework*. *Ghana Journal of Forestry*. 11(2): 1-13.
- Eliasson, G. 2001. *Economic Role of Technology in a Competence Bloc Based Industrial Policy Analysis*, In: Sweeney, G. (Ed.), *Innovation, Economic Progress and the Quality of Life*. Edward Elgar Publishing Inc., UK. 182pp.
- Ellefson, P. V. and R. N. Stone. 1984. *U. S. Wood-Based Industry: Industrial Organization and Performance*. Praeger Publishers, New York. 479pp.
- Feldman, M. P. and N. Massard. 2002. *Location, Location, Location: Institutions and Systems in the Geography of Innovation*, In: Feldman, M. P. and N. Massard (Eds.), *Institutions and Systems in the Geography of Innovation*. Kluwer Academic Publishers, London. 365pp.

- Ghana Forestry Commission. 2004. A News Letter about Ghana's Forests, Timber and Wildlife. Ghana Gazette. No. 32. June/July. 11pp.
- Hair, J. F., W. C. Black, B. J. Babin, R. E. Anderson and R. L. Tatham. 2006. *Multivariate Data Analysis*. 6th Edition. Pearson Education Inc., NJ. 899pp.
- Hansen, E., H. Juslin and C. Knowles. 2007. Innovativeness in the Global Forest Products Industry: Exploring new Insights. *Canadian Journal of Forestry Research*. 37(8): 1324–1335.
- Hershey, J. 2004. How to Build with Bamboo: 20 Projects you can do at Home. *Library Journal*, New York. 129(20): 158.
- Hippel, E. 1988. *The Sources of Innovation*. Oxford University Press, New York. 218pp.
- Hiziroglu, S., S. Jarusombuti, V. Fueangvivat, P. Bauchongkol, W. Soontonbura and T. Darapak. 2005. Properties of Bamboo-rice Straw-eucalyptus Composite Panels. *Forest Products Journal*. 55(12): 221-225.
- Houtkoop-Steenstra, H. 2000. *Interaction and the Standardized Survey Interview. The Living Questionnaire*. Cambridge University Press. 209pp.
- Hovgaard, A. and E. Hansen. 2004. Innovativeness in the Forest Products Industry. *Forest Products Journal*. 54(1): 26-33.
- Kent, R. 2001. *Data Construction and Data Analysis for Survey Research*. Palgrave Publishers Ltd., New York. 251pp.
- Knowles, C., E. Hansen and C. Dibrell. 2008. Measuring Firm Innovativeness: Development and Refinement of a New Scale. *Journal of Forest Products Business Research*. 5(5): 1-25.
- Mahajan, V. and R. A. Peterson. 1985. *Models for Innovation Diffusion*. Sage Publications Inc., CA. 86pp.
- Neuman, W. L. 2003. *Social Research Methods: Qualitative and Quantitative Approaches*. 5th Edition. Pearson Education, Inc. 584pp.
- Oteng-Amoako, A. A., D. A. Ofori, L. C. N. Anglaaere, B. Obiri-Darko, and E. Ebanyenle. 2004. Sustainable Development of Bamboo Resources. Africa Forestry Research Network (AFORNET), Ghana Processing Report 1 (unpublished), (Jan-Dec. 2004). 13pp.
- Paudel, S. K. and J. U. Moran. 2004. Model Bamboo House in Guyaquil, Ecuador. *INBAR News* 11(2).
- Porter, M. E. 1990. *The Competitive Advantage of Nations*. The Free Press, New York. 855pp.

Porter, M. E. and S. Stern. 2002. Innovation: Location Matters, In: Roberts, E. B. Innovation: Driving Product, Process and Market Change. Jossey-Bass, CA. 343pp.

Rogers, E. M. 2003. Diffusion of Innovations. 5th Edition. Free Press, New York. 551pp.

Ruiz-Perez, M., F. Maoyi, Y. Xiaosheng, and B. Belcher. 2001. Bamboo Forestry in China: Toward Environmentally Friendly Expansion. *Journal of Forestry*. 99(7): 14-20.

Sumardi, I., S. Suzuki and K. Ono. 2006. Some Important Properties of Strand Board Manufactured from Bamboo. *Forest Products Journal*. 56(6): 59-63.

Unger, B. 2005. Problems of Measuring Innovation Performance, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems*. Edward Elgar Publishing Ltd., UK. 307pp.

Vlosky, R., and N. P. Chance. 2001. Employment Structure and Training Needs in The Louisiana Value-Added Wood Products Industry. *Forest Products Journal*. 51(3): 34-41.

Waarden, F. 2005. A Prototypical Institution: Law, Regulation and Innovation, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems*. Edward Elgar Publishing Ltd., UK. 307pp

Wagner, E. R. and E. N. Hansen. 2005. Innovation in the Large Versus Small Companies: Insights from the U.S. Wood Products Industry. *Management Decision*. 43(5/6): 837-850.

Weber, C. 2002. *New Bamboo*. Builder, Washington. 25(7): 34.

CHAPTER 5: ADOPTION OF BAMBOO AS PERCEIVED BY RELEVANT INSTITUTIONS IN GHANA'S FOREST PRODUCTS INDUSTRY

Introduction

For bamboo to be adopted there are several institutions that will play valuable roles. This chapter focuses on the institutions relevant to Ghana's forest products industry. The decline of Ghana's forest resource necessitated a study to determine the extent to which the forest products industry would be interested in adopting bamboo as an alternative raw material. Data was first gathered about the current situation in the industry. The results indicated that, the decline of Ghana's timber raw material supply has seriously impacted the forest products industry. This is the basis to investigate the possibility of introducing bamboo as alternative raw material for the forest products industry.

Several barriers (e.g., lack of information and technological know-how about bamboo) that might impact the adoption of bamboo in the forest products industry were identified in the previous chapter. In addition, companies have several needs that have to be filled before they will adopt bamboo. Several of the barriers that exist may have to be eliminated by relevant institutions in order to set the stage for bamboo adoption. To promote innovation, (e.g., the use of bamboo in Ghana's forest products industry), the involvement of institutions cannot be overemphasized (Hage, 2005; Rochlin, 2006; Porter and Stern 2002; Porter 1990; Eliasson, 2001; Feldman and Massard 2002; Waarden 2005). This chapter seeks to identify the efforts needed by relevant institutions and industry associations to encourage the adoption of bamboo in Ghana's forest products industry. To meet this goal the following objectives need to be achieved.

Objectives

- (i) To identify barriers and needs (e.g. research, logistics, cost, cognition, personnel, etc.) as perceived by policymakers and industry associations that may affect their ability to influence increased adoption of bamboo as a raw material in the forest products industry.
- (ii) To suggest policies for all stakeholders for the successful adoption of bamboo.

Methods and Data Collection

As with the industry CEOs, a semi-structured interview schedule (Neuman, 2003; Houtkoop-Steenstra, 2000; Aldridge and Levine, 2001; Alreck and Settle, 2004) for surveying institution representatives was designed and administered. The questions sought to determine the barriers to bamboo adoption and needs for adoption perceived by institutional heads. In addition, open-ended questions were used to help determine policies appropriate to foster increased management, utilization and marketing of bamboo and bamboo products.

Population and Sample Frame

The population of the study is the relevant institutions in the forest products industry in Ghana. These include forestry related policymakers (government agencies), educational institutions, industry associations and promotional/economic development agencies (e.g. the Forestry Department, banks, the Ghana Timber Millers' Organization, FORIG and the Wood Science Department of the Kwame Nkrumah University of Science & Technology). These institutions work in all four regions – Greater Accra, Ashanti, Western, and Brong Ahafo where commercial timber activity is concentrated. See **Appendix A** for a map of Ghana showing the sample frame.

Sample

Respondents (heads of institutions) were surveyed through a purposive/judgmental sampling method according to peer reviewed sources (i.e., Neuman, 2003; Smith and Albaum, 2005; Alreck and Settle, 2004; Kent, 2000; Aldridge and Levine, 2001). Institutions canvassed included the Ghana Forestry Department, the Forestry Research Institute of Ghana (FORIG), the local office for the International Network for Bamboo and Rattan (INBAR), the Agricultural Development Bank, the Ghana Timber Millers Organization (GTMO), the universities and polytechnics, the Timber Industry Development Division (TIDD), the Ghana Export Promotion Council (GEPC), and the Furniture and Woodworkers Association of Ghana (FAWAG). These organizations are affiliated with the industry and presumably have the right information about the industry. Their perceptions about existing barriers and needs were useful in developing policy and management strategies. In all, 32 institutional heads were interviewed.

The survey for the institutions was pretested with few research personnel and institutional heads in Kumasi. The pretest was helpful in identifying and clarifying questions and minimizing ambiguity. After the pretest was completed the questionnaires were finalized and copied. To save time and minimize expenses, data for the industry and institutions were gathered on the same research trip from late November 2007 to early February 2008 through personal interviews.

Appendix D is a full replica of the questions used for institutions. The same approach of the data collection and handling process described in Chapter 4 was used for the institutions.

Data Analysis

Once the data was tabulated in spreadsheets, SPSS software calculated mean responses to determine the degree to which the survey items and variables are important. It was important to

ensure cross validation of the data given the small sample size. Hence analyses were completed for both survey items and variables. The standard deviation and percent of responses were obtained to show the spread and distribution of the data. All open-ended data was analyzed descriptively and qualitatively. Results from this chapter and previous chapters are synthesized with important points from innovation and change management literature to obtain final models for the study presented in Chapter 6.

Results from Institutions and Discussion

Data and discussion gathered from the questionnaire for institutions sought to describe the capabilities of institutional heads to provide assistance to the industry and identify barriers and needs of the institutions. This part of the study helps to address some questions raised by Research Question 1 (i.e. identifying barriers and needs) and Research Question 4 (i.e. identifying the importance of institutions in the bamboo adoption process and their policy suggestions). The study falls in three parts. In the first part, results for the Likert scale type of questions are presented. Respondents were asked about what activities they have already done that indicate their readiness to help the industry to adopt bamboo, or what they do not have yet but hope to be able to provide in the future to facilitate adoption of bamboo by the industry.

In the second part, respondents were asked to rank their resource availability using a numeric scale. The items used on the scale were thought to be some of the barriers that these institutions may have to circumvent in order to efficiently promote the adoption process. Lower mean scores imply that barriers exist to a higher degree. Higher mean scores indicate that the resources are available to a higher degree. The third part of this section comprises responses to open-ended questions. In some of the questions, respondents were asked explain their perceived barriers and needs.

Table 5.1: Why is Your Institution Important in Ensuring Adoption of Bamboo?

1. Trains, researches and disseminates research results
2. Provides tree seedlings to industry; in charge of seedling technology and production
3. Provides financial support
4. Represents furniture companies and does lobbying in parliament
5. Mouthpiece for the industry; have all industry contacts
6. In charge of exports
7. Main government agency that oversees investment in Ghana
8. Non-profit organization promoting use of bamboo
9. Promotes exports
10. Trains students
11. Does research (research institution)
12. Represents small scale carpenters
13. Controls production, quality and marketing of products
14. Oversees forestry related issues
15. Sets standards for wood products and promotes products
16. Provides advice on land and soil use issues
17. Assists with establishment of the resource base
18. Responsible for management, development and utilization of forest resources
19. Represents loggers
20. Promotes bamboo utilization in the forestry department
21. Promotes bamboo utilization in the country
22. Trains forest and timber personnel

Other questions sought to elicit suggestions from respondents that would help in formulating policies for the successful adoption of bamboo in the industry and help the institutions to operate more efficiently. To begin, respondents were asked to state whether they

are really responsible or capable of helping the forest products industry to adopt bamboo. Their responses and reasons are presented in the next section.

Importance of Institutions in Ensuring Adoption of Bamboo

It was assumed that institutions would have to actively promote adoption of bamboo in Ghana's forest products industry. Thus, to answer research question 4, respondents were asked to indicate whether they are important in the bamboo adoption process. All responded in the affirmative, i.e., they are all important in helping initiate adoption of bamboo in Ghana's forest products industry. Respondents were asked to state the reasons why their agency is important in the bamboo adoption process. **Table 5.1** indicates several functions stated by the respondents, which indicate that when all these entities collaborate on bamboo related issues, it could be easier to implement the project. The functions include training of students and industry personnel, promotion of the industry's products, and provision of financial support.

Capabilities, Resource Availability and Barriers to be Removed

The degree to which institutions are prepared to facilitate adoption of bamboo was determined by finding out what they have already done to help the industry and what they can provide in the future. **Table 5.2** shows the frequency and percentage distribution of the current availability of resources to respondents in their readiness to promote adoption of bamboo in the industry. **Table 5.3** shows the frequency and percentage distribution of the degree to which respondents are capable of providing resources to the industry in the future but not now. **Table 5.2** and **5.3** were contrasted to obtain **Table 5.4** which helps us to determine the gaps that we need to fill. The responses 'strongly agree' and 'agree' in **Table 5.2** were considered to be an indication that the resources are available now and that the institutions can use these resources

currently to help the industry to adopt bamboo. Using research to explain the table, it is indicated that four institutions agree/strongly agree to have done research whose results can currently assist the industry to adopt bamboo.

On the contrary, the ‘strongly agree’ and ‘agree’ responses in **Table 5.3** show that those resources are not available now or cannot be provided for the industry now and thus cannot support bamboo adoption in the current situation.

Table 5.2: Frequency Distribution for Degree of Current Resource Availability and Capabilities (N=32)

Item respondent already has available	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	Count	%	Count	%	Count	%	Count	%	Count	%
Land use information	7	21.9	4	12.5	0	0	20	62.5	1	3.1
Planting information	6	18.8	3	9.4	3	9.4	18	56.3	2	6.3
Ownership policies	6	18.8	4	12.5	4	15.5	16	50.0	2	6.3
Plantation mgt. info	7	21.9	1	3.1	2	6.3	15	46.9	7	21.9
Species	9	28.1	1	3.1	4	12.5	10	31.3	8	25.0
Showcase facility	4	12.5	2	6.3	1	3.1	21	65.5	4	12.5
Research staff	6	18.8	2	6.3	1	3.1	19	59.4	4	12.5
Product examples	8	25.0	3	9.4	1	3.1	18	56.3	2	6.3
Research	4	12.5	0	0	0	0	27	84.4	1	3.1
Convinced customers	4	12.5	1	3.1	3	9.4	24	75.0	0	0
New customers	3	9.4	1	3.1	6	18.8	22	68.8	0	0
Environmental Policy	3	9.4	1	3.1	5	15.6	22	68.8	1	3.1
Use guidelines	4	12.5	1	3.1	5	15.6	22	68.8	0	0
Treatment guidelines	8	25.0	1	3.1	2	6.3	19	59.4	2	6.3
Market information	6	18.8	0	0	4	12.5	20	62.5	2	6.3
Public awareness	5	15.6	0	0	1	3.1	26	81.3	0	0
Machine information	6	18.8	0	0	4	12.5	20	62.5	2	6.3
New equipment info	6	18.8	1	3.1	3	9.4	20	62.5	2	6.3
Loans for farmers	1	3.1	1	3.1	3	9.4	11	34.4	16	50.0
Loans for companies	1	3.1	0	0	5	15.6	9	28.1	17	53.1
Grading standards	2	6.3	1	3.1	2	6.3	22	68.8	5	15.6

The ‘neutral’, ‘disagree’ and ‘strongly disagree’ responses do not help in determining the gaps because they do not give an indication of any readiness to contribute in implementing the change. However, as shown in **Table 5.3**, 31 institutional heads agree/strongly agree that they could actually conduct research in the future and provide research results to the industry. It means that the gap (those willing to help but are incapable now) is 27. As shown in **Table 5.4**, it implies that, 27 of the 31 institutions are unprepared to provide research and research results to the industry.

Table 5.3: Frequency Distribution for Capability to Provide Future Resources (N=32)

Item respondent can provide in the future but not now	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	Count	%	Count	%	Count	%	Count	%	Count	%
Land use information	14	43.8	12	37.5	0	0	5	15.6	1	3.1
Planting information	11	34.4	12	37.5	3	9.4	4	12.5	2	6.3
Ownership policies	7	21.9	15	46.9	4	12.5	4	12.5	2	6.3
Plantation mgt. info	9	28.1	10	31.3	2	6.3	4	12.5	7	21.9
Species	11	34.4	7	21.9	4	12.5	2	6.3	8	25.0
Showcase facility	11	34.4	10	31.3	1	3.1	6	18.8	4	12.5
Research staff	11	34.4	15	46.9	1	3.1	1	3.1	4	12.5
Product examples	13	40.6	11	34.4	1	3.1	5	15.6	2	6.3
Research	21	65.6	10	31.3	0	0	0	0	1	3.1
Convince customers	13	40.6	14	43.8	3	9.4	2	6.3	0	0
New customers	12	37.5	12	37.5	7	21.9	1	3.1	0	0
Environmental policy	10	31.3	12	37.5	4	12.5	5	15.6	1	3.1
Use guidelines	14	43.8	8	25.0	5	15.6	5	15.6	0	0
Treatment guidelines	10	31.3	8	25.0	3	9.4	9	28.1	2	6.3
Market information	15	46.9	9	28.1	4	12.5	2	6.3	2	6.3
Public awareness	22	68.8	8	25.0	1	3.1	1	3.1	0	0
Machine information	14	43.8	9	28.1	4	12.5	3	9.4	2	6.3
New equipment info	14	43.8	10	31.3	3	9.4	3	9.4	2	6.3
Loans for farmers	4	12.5	5	15.6	3	9.4	3	9.4	17	53.1
Loans for companies	5	15.6	1	3.1	5	15.6	4	12.5	17	53.1
Grading standards	7	21.9	14	43.8	2	6.3	4	12.5	5	15.6

Table 5.4: Differences between Current and Future Capabilities (N=32)

Survey Item	Already have	Could provide in the future ¹²	Gap ¹³	Percent
Grading standards	2	21	19	90.5
Research	4	31	27	87.1
Public awareness creation	5	30	25	83.3
New customers	4	24	20	83.3
Loans to companies	1	6	5	83.3
Environmental policy	4	22	18	81.8
Convince customers	5	27	22	81.5
Loans to farmers	2	9	7	77.8
Guidelines for bamboo uses	5	22	17	77.3
Market information	6	24	18	75.0
Machine information	6	23	17	73.9
Showcase facility	6	21	15	71.4
New equipment information	7	24	17	70.8
Research staff	8	26	18	69.2
Ownership policies	9	22	13	59.1
Planting procedures	10	24	14	58.3
Information on plantation management	8	19	11	57.9
Land use information	11	26	15	57.7
Product examples	11	24	13	54.2
Treatment guidelines	9	18	9	50.0
Species	10	18	8	44.4

The variable with the biggest gap is grading standards (90.5%) followed by research (87.1%), and public awareness (83.3%), new customers (83.3%) and loan acquisition (83.3%). About 83% of respondents who are capable of creating awareness have currently not done so. This implies that little has been done in developing standards for bamboo. In addition, little has been done in research and awareness creation about bamboo.

¹² Includes those who already have resources

¹³ Can only provide in the future

Variable Analysis for Capabilities

The survey items that were used to determine the degree of current and future capabilities of the institutions were further categorized into variables, i.e., public awareness, expertise, capital/funding, market initiative, processing information and planting information. Means were calculated for the means of the items of similar nature. For the example, the item, public awareness creation that bamboo is a good material was used for the variable, public awareness. To define expertise, the availability of research staff and ability to do research were combined. The items combined for capital/funding include the availability of a showcasing facility, and the ability to provide loans to farmers and companies. Market initiative is the result of combining the availability of effective marketing procedures, the ability to convince the industry's customers to buy bamboo products, readiness to look for new customers, the availability of guidelines for the utilization of the harvest bamboo, existing examples of bamboo products, and the availability of grading standards.

For processing information, the items considered are the availability of guidelines for treatment of bamboo, and the availability of information as to how new and used processing equipment can be acquired by the industry. The items that were used for planting information are the availability of land use information, information on planting procedures, and information on ownership policies. The rest are the availability of useful species, information on bamboo plantation management the availability of environmental policy instruments to guide bamboo plantation management. **Table 5.5**, a hybrid of **Table 5.4** shows the gaps that were obtained for these variables. Lack of 'public awareness' appears to be the biggest gap (i.e. 83.3%). This means that institutions that are responsible for creating public awareness have done only little and need to put in more efforts to promote bamboo. This is followed by lack of expertise

(78.2%), lack of capital (77.5%) and lack of market initiative (77.0%). The other gaps are lack of processing information (64.9%) and lack of planting information (59.9%). This can also be interpreted to mean that the type of information that institutions can most readily provide in the current situation is planting information. The information they have provided the least in the current situation is public awareness.

Table 5.5: Differences between Current and Future Capabilities (Variables)

Variable	Gap%
Public awareness	83.3
Expertise	78.2
Capital/funding	77.5
Market initiative	77.0
Processing information	64.9
Planting information	59.9

Resource Availability and Needs of Institutions

The resources available to respondents indicate their readiness to assist the industry to adopt bamboo. **Table 5.6** shows the survey item response for resource availability to institutions and how important they are as barriers on a five-point scale. The scale is 1 for extremely not available and 5 for available in abundance.

Table 5.6: Importance of Resource Availability to Institutions (N=32)

Survey Item	Mean	Std. Deviation
Qualified personnel	3.13	1.212
Opportunities to help industry to try innovation	2.91	1.088
Product development capability	2.81	1.120
A major training facility	2.75	1.270
Examples to show industry	2.75	1.270
Availability of technical advice	2.72	1.198
Availability of market information expertise	2.66	1.066
Opportunities for industry to observe application	2.63	1.264
Availability of research personnel	2.41	1.266
Extension personnel	2.22	1.338
Research funding	1.84	1.081

‘Qualified personnel’ has the highest mean score of 3.13 for resource availability on a five-point scale. This is followed by ‘opportunities to help the industry to try the innovation’ (mean = 2.91) and product development capability (mean=2.81). These are low scores and indicate that institutions are more likely to need all these resources. The variable that is least available to institutions is research funding (1.84); this is the most important need. It also has almost the lowest standard deviation (1.081) which shows greater significance. In cross validating with the results in **Table 5.4** where the gap for research is as high as 87.1%, one can conclude that inadequate research funding is an important need. Other important needs are having more extension and research personnel, and increased opportunities for firms to observe the application of the innovation from the institutions. In reality, all these are important needs since they are barely available to the institutions given their low mean scores.

Variable Analysis for Resources

Figure 5.1 shows the values for variables obtained from categorization of the survey items in **Table 5.6** to obtain a summary of the degree of resource availability and needs. The needs are exposure, skill/expertise and capital. Since a multivariate analysis could be performed items of similar nature were clumped to define clear needs. The items combined for exposure are opportunities to try the innovation or help the industry to try, opportunities for the industry to observe the application of the innovation from institutions and available examples to show the industry how bamboo is being used. For skill/expertise, the items combined are the availability of research staff, technical advice and market information personnel, qualified extension personnel, and product development capability. The items combined for capital include a facility to be a major training base for the innovation and funding. On a five-point scale, respondents appear to have had more exposure (mean=2.76) about bamboo than their level of expertise (mean=2.66) and capital endowment (mean=2.30). However, all these can be considered to be major needs. Exposure to the innovation with a mean score of 2.76, i.e., the variable most available almost matches the opportunities institutions have to help the industry to try the innovation as this ranks second in the survey item list.

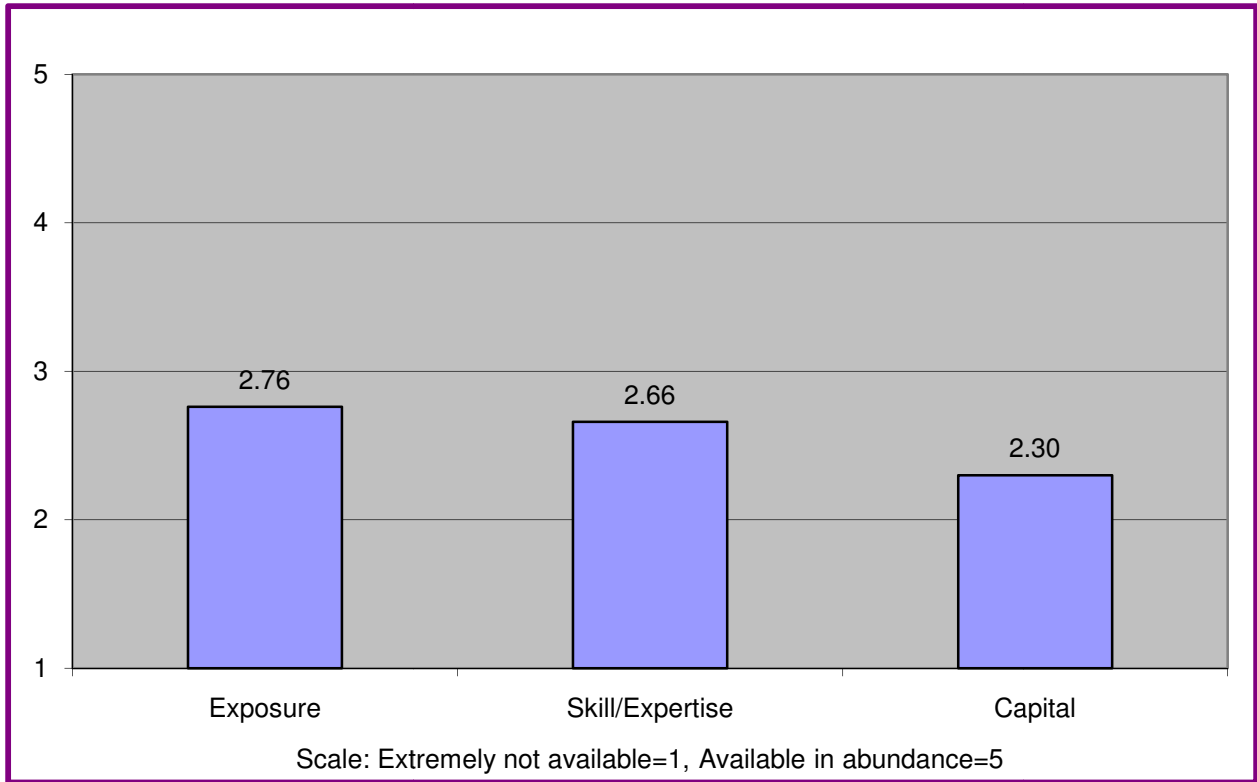


Figure 5.1: Measure of Importance of Availability of Resource (Variables)

Capital is the variable that is least available to the institutions. This includes funding, laboratory equipment, research resources and related logistics. This confirms the survey item result that funding is lacking.

Open-ended Questions for Institutions

Open-ended questions were used to gather more information from institutional heads regarding what they perceive to be barriers and needs. They also helped in consolidating suggestions that might be useful for policymaking regarding the adoption of bamboo in Ghana. This section discusses the responses to open-ended questions. It first addresses perceived barriers and needs and then provides suggestions for policymaking.

Barriers Perceived by Institutions

The main barriers that are perceived by the directors of institutions when responding to open-ended questions are shown in **Table 5.7**. They are lack of information on policies, lack of funding, lack of bamboo technology and information, poor perception about bamboo and lack of collaboration among stakeholders. The rest are poor quality of existing bamboo species, conservativeness of the industry to change, non-implementation of research results and lack of long-term finance for the industry.

Table 5.7: Frequency Distribution of Institutions' Major Perceived Barriers (from Open-ended Questions) (N=32)

Major barrier faced by institution	Number of respondents who mentioned this barrier	Percent
Lack of information on policies	20	62.5
Lack of funding	17	53.1
Lack of technology	16	50.0
Poor perception about bamboo	14	43.3
Weak collaboration among stakeholders	10	31.3
Poor quality of existing bamboo species	9	28.1
Conservativeness of industry to change	7	21.9
Non-implementation of research results	6	18.8
Lack of long-term finance	4	12.4

Lack of Information on Policies and Poor Perception about Bamboo

The barrier with the highest percent (62.5%) identified by respondents is lack of information on policies. Respondents deplored the absence of a policy framework on bamboo utilization in the country. Most respondents are not aware about policies on products and markets. The banks would like to see government policies that support investment in bamboo

processing; such policies are currently lacking. Hence it is difficult for the banks to provide loans for bamboo ventures.

Bamboo is considered an inferior material in Ghana as indicated by 43.3% of respondents. Some respondents believe that some institutions and investors lack interest in the material. The poor perception about bamboo is described by some respondents as a lack of social acceptance and a cultural barrier that compounds efforts by advocacy groups to convince others to use it. Some respondents believe that the current standing volumes of the dominant bamboo species (*Bambusa vulgaris*) are inadequate and of poor quality. Some commonly known problems about the dominant species are its fluctuating moisture content, susceptibility to insect infestation and cracking during the dry season. Given these problems, the dominant species is perceived to be an undesirable raw material for the industry.

Lack of Technology and Information

Fifty percent of the respondents mentioned lack of technology and information as barriers that might impact their ability to influence the industry to adopt bamboo. The institutions lack planting and propagation expertise, species information and harvesting know-how. They also do not have adequate information about the technical properties of bamboo and lack adequate information about processing and equipment. There is inadequate information about treatment procedures and cost implications. The number of scientists that are capable of doing research in bamboo is small. Trained technical personnel are also not adequately available to provide technical assistance. The technology is not being taught in schools so knowledge in bamboo usage is limited.

Lack of Funding

About 53% of respondents feel that lack of funding is a major barrier in their efforts to help the industry adopt bamboo. This is the second most important barrier and compares with the results from the closed-ended questions. Many of the scientists need state-of-the-art laboratory equipment to undertake research. Respondents that do tree seed research for instance, expressed the need for funding to do research in seed technology. Finances are generally scarce for research. Researchers would like to organize workshops and publish their results in manuals, technical papers and leading journals to promote bamboo.

Twelve percent of respondents share with industry and other investors about the need for long-term loans from banks and think this is a key barrier to institutions' ability to implement bamboo projects. Initial finance from banks may help companies and farmers to establish but may not be able to sustain the investment. The unwillingness of banks to give long-term loans is discouraging.

Lack of Collaboration

As high 31.3% of respondents admit that there is not much interaction and collaboration among the relevant institutions. For instance, there is little collaboration between research institutions, banks, the government and the industry. This means that communication is inefficient. Collaboration was perceived by some respondents as a way that would inform the industry about ongoing research projects and encourage them to provide funding to research institutions. Collaboration was also perceived by respondents to encourage banks and other stakeholders to be more interested in development projects. In addition, there is sometimes little collaboration between departments in the same organization.

Approximately 19% of respondents dislike the government's lassitude attitude toward the use of research reports. Little attention is paid to such reports, which contain proposed policy approaches to pertinent issues. The government's bureaucracy is partly blamed for this. In effect, research results are invariably not implemented. Researchers get discouraged at the government's slow pace toward policy implementation; the government is best known for its noisemaking attitude about initiatives but slowness in the implementation of results.

Nearly 22% of respondents have the notion that the forest products industry is not willing to change and always wants to keep to traditional species. Some institutional heads expressed sentiments that the industry is accustomed to processing wood, a stance that makes it difficult to persuade or convince them to adopt alternative species. Their reluctance to change could be due to the conservative nature of buyers; buyers want traditional species such as *Milicia excelsa* (odum). Some respondents deplored the industry's lack of interest toward programs organized by their representatives, i.e., GTMO and Ghana Timber Association (GTA). Most companies do not attend meetings, workshops or seminars. Such conservative attitude is perceived by some institutional heads as a major barrier that could inhibit their efforts to influence the industry to adopt bamboo. Although this section presents barriers perceived by institutions, it was decided to also determine barriers perceived by industry associations. As the associations represent the industry, it is believed that their input represents exactly what the industry desires.

Barriers Perceived by Industry Associations

The industry's associations have certain concerns that they feel are worth resolving in order to facilitate adoption of bamboo. They believe that bamboo plantations may compete with crops for land. Being a rhizome which spreads fast, the possibility of bamboo plantations becoming invasive is high. Respondents also envisage problems with harvesting; it is difficult to

cut clusters of bamboo. Others feel that bamboo products might not appeal to their customers. It was gathered that the industry currently finds it difficult to sell furniture products in international markets due to poor or lack of uniform quality. Hence, they are skeptical about the market success for bamboo products.

Needs Perceived by Institutions

In the following section, the needs that were identified by institutions in response to open-ended questions are discussed. As shown in **Table 5.8**, they include funding, technical information and training, creation of awareness and provision of lab equipment and accessories.

Table 5.8: Frequency Distribution of Institutions' Major Perceived Needs (from Open-ended Questions)

Major Need of institution	Number of institutions that mentioned this need	Percent
Funding	23	71.9
Technical information	21	65.6
Training	21	65.6
Awareness creation	16	50.0
Lab equipment	12	37.5
Collaboration	7	21.9
Change in perception	3	9.4

Funding, Lab Equipment and Other Accessories

Most of the respondents consider funding for bamboo research as very important. Funds are needed to purchase the necessary resources that would enhance their efforts in promoting bamboo. They need funds for several activities including market promotion, research, training and research result dissemination through workshops, seminars and meetings. Researchers

would like laboratories equipped with mini-prototype equipment that can demonstrate bamboo product manufacturing. There is need to establish a bamboo arboretum at an experimental station.

Awareness Creation, Technical Information and Training

Awareness creation is another important need of respondents. Fifty percent of respondents realized the need for awareness creation and want to be adequately equipped so that they can efficiently participate in making the benefits of using bamboo known (**Table 5.8**).

The second most important need perceived by respondents (65.6%) is training, to equip them in various aspects of the bamboo supply chain. Some respondents advocate the exposure of district and regional managers of institutions to the innovation so that they can support it. Trained technical personnel and extension agents are expected to provide information on all aspects of the bamboo supply chain.

In the following section, the answers to the questions that sought to determine who respondents believe are responsible for removing the perceived barriers and meeting the anticipated needs are presented.

Entities Responsible for Removing Barriers

To simplify the task of responsible authorities to address the barriers, institutional heads were asked to mention those entities they believe are responsible for removing the perceived barriers (**Table 5.9**). This part helps in answering research question 4 which seeks to determine whether institutions conceive themselves as important in bringing the bamboo adoption process to a success.

The government is believed to be very important in helping remove the perceived barriers. Other important entities include banks and financial institutions, landowners and traditional authorities, research institutions, and companies that sell machinery. The functions of these institutions are also summarized in the table.

Table 5.9: Entities Responsible for Removing Perceived Barriers

<ul style="list-style-type: none"> • Government, e.g., Ministry of Lands and Forestry, Forestry Commission, Forestry Department, Timber Industry Development Division, Ministry of Trade and Industry, Ministry of Finance, Ministry of Information, Lands Commission, Ministry of Education – develop policies for bamboo adoption • Banks, financial institutions – provide long-term finance • Landowners, chiefs, traditional authorities, district assemblies, families holding lands – cooperate in resolving land tenure conflicts and plant bamboo • Forestry Research Institute of Ghana (FORIG), soil scientists – conduct research • Equipment companies – provide adequate information about machines • Educational institutions – provide training and research data • Industry associations, e.g., Association of Ghana Industries, Ghana Timber Association, Ghana Timber Millers’ Organization, Furniture and Wood Workers Association of Ghana, Small Scale Carpenters – convince industry to use bamboo • Standards board of Ghana – develop grading standards • Ghana Export Promotion Council, Tourist Board – promote bamboo • Development partners, e.g., INBAR, donor agencies, environmental organizations, NGOs – promote bamboo and provide financial support and capacity building

All

these institutions are urged to collaborate and develop strategies toward the successful adoption of bamboo in the forest products industry. In the previous section the perceived barriers and needs of institutions in their bid to promote the use of bamboo in Ghana’s forest products industry was discussed. Barriers and needs abound. In addressing these barriers and needs, the following section presents policy and management suggestions from the heads of the institutions.

Policy and Management Suggestions from Institutional Heads

What follows is a summary of suggestions that can foster adoption of bamboo.

Improvements include land use, bamboo plantation management, cultural practices, ownership, loan acquisitions, credit and subsidies for establishing plantations, ensuring distributive justice and research. Others are extension and technical service, marketing, management, utilization of products, and exports and imports. It is important to gain a deeper insight of each group so that recommendations can be made.

Land Use

Bamboo is known to be a rhizome with gluttonous morphological characteristics which makes it less accommodating to other crops. In that respect, it is more likely to be grown as a mono crop demanding large acreages of agricultural land. One cannot easily grow any other plant in bamboo growing areas, so land selection is very important. The government would need to develop land policies that are favorable for all land use activities including agriculture. Some respondents have cautioned that it is important to consider the financial returns in comparison with food crops before allocating land for bamboo mono cropping. The forestry and land commissions need to identify appropriate soils and map them out for bamboo plantations.

Land tenure has been identified as a possible source of problems. Respondents have suggested to the government to address the current land tenure system which confers unlimited authority to families and traditional leaders. The system is a barrier to commercial farming and plantation management since the land belongs to a group of people who may not all agree on the best way to utilize it. In addressing land tenure problems, all stakeholders including family heads and traditional authorities should be involved.

The use of land areas granted by the forestry commission for afforestation and reforestation for bamboo plantations could preclude interference from custodians of family lands. Fortunately, a government initiative is underway to address the land tenure system in Ghana. Another way to avoid the implications of land tenure is to adopt the out-grower production scheme. In this system, the land owner is contracted by a company to grow crops. The company provides all inputs for the landowner to undertake the project. In the end, both the company and the farmer benefit from the proceeds. Others propose that district assemblies acquire land and employ people to do the planting.

Respondents advocate a policy that would ensure equitable access to land by all citizens. However, we know from resource economics that, in situations where property rights are not well defined, conflicts abound. Landowners need to be motivated to give out land for commercial projects. The land commission should work with land owners and chiefs and their lawyers to develop appropriate ways for land use.

Plantation Management

Respondents suggested that the Ghana government enact policies that would encourage the use of bamboo. As noted earlier, bamboo spreads fast if not well managed. Following good management practices and applying sustainable harvesting techniques are important. To avoid the incidence of bamboo becoming a nuisance, exotic species that grow like trees are proposed. Silvicultural treatments are needed to ensure proper growth of bamboo plantations. For bamboo plantation management to be successful, some institutional heads have advocated training programs for forestry technical officers. Some of the good management practices that are proposed to be considered in policymaking are good species-site matching, cost benefit analysis,

construction of access roads into plantations, felling cycle establishment and education of communities to prevent forest fires.

To achieve successful plantation management, some respondents propose subvention from the forestry department e.g., some revenues from the heavily indebted poor countries (HIPC) initiative could be used to financially support bamboo plantation owners. In addition, a special tax on the harvest of highly priced primary timber species should provide income to support bamboo plantations. To further bolster plantation management, it is recommended that the government mandate forest products companies to include bamboo plantation management in their management plans.

Research in cultural practices such as pruning and topping is encouraged. Standing bamboo poles have to be marked with different colors according to their age in order to differentiate between them during harvesting. Bamboo requires more management attention than trees because it grows fast and can become uncontrollable. If not managed well it gets crooked and loses its quality. Dead and over mature poles need to be extracted. In establishing plantations it is important to establish property rights to avoid conflicts.

Before venturing into bamboo plantation management, the Ministry of Lands and Forestry should develop management plans for managing the already existing bamboo stands in the country, said some respondents. There is an abundant amount of bamboo in Manso Amenfi in the western region and other areas in the country that is not being used; when this is efficiently used, one can advocate bamboo plantation growth. The ministry should provide information about harvesting methods. Other respondents urged that relevant institutions such as BARADEP, TIDD and GFC to develop both plantation and business management strategies.

Ownership

The type of plantation ownership that should exist depends on the prevailing type of land ownership. Some respondents propose an individual ownership of bamboo plantations while others propose community ownership. If plantations are owned by individual landowners, it may be difficult for them to acquire loans as banks are reluctant to lend money to individual farmers who invariably divert loans into other non-profit yielding activities. However, a good proposal supported with collateral can procure loans. Companies can also acquire land in reasonable sizes and provide financial support for out-growers to establish and maintain the plantations.

Community ownership which was suggested by a number of respondents looks more attractive. For example, a plantation purported to be owned by the district assembly is more likely to win financial support; it is also more sanguine of management success. If the district assembly owns the plantations, it will employ farmers and pay them for their work. Community ownership could also be shared ownership between a company and the community. This, and district assembly ownership are more likely to engage a larger group of stakeholders to be responsible in management, hazards fighting e.g., fires, proceed sharing, and equity in many respects than individual ownership. The results from the industry show that companies are not ready to establish their own plantations. So community and district assembly ownership of plantations would auger well for the industry.

The Ghana Timber Association (GTA) has 280 hectares of teak plantation on a land that was allotted by the forestry commission. There is a procedure for sharing proceeds from plantations of the government, associations, communities and the district assembly. As the government has done with teak, the forestry department can establish bamboo plantations and sell to companies. Notwithstanding, if bamboo becomes a perpetual plant at a particular site, the

period for ownership can be long. This may become problematic in areas where land tenure system still dominates as the only means to access land.

Access to Loans

It takes several years for trees to reach maturity but bamboo matures in about three years, a cycle that is promising for business. Banks are urged to provide loans to investors to establish bamboo plantations and invest in processing equipment. Nonetheless, some respondents, including the banks expressed regret at the rate at which farmers default in paying back loans. To avoid bankruptcy, some respondents have suggested help to farmers in the form of subsidies and services rather than in cash. For instance, researchers could rather be given financial support to conduct research and the results, e.g., improved seeds and technical service, made freely available to farmers and other stakeholders. One way that banks can retrieve loans from farmers could be an acceptance of the final product from the farmers rather than money. There have been cases where farmers were cajoled into producing certain crops with a failed promise from the government to provide markets. For example, farmers were recently encouraged to produce cassava on a commercial basis for supply to a local manufacturing facility but the facility never got built. In the end, farmers could not pay back their loans.

Bank managers would like to see evidence of markets for bamboo and bamboo products before granting loans. They want to know that the markets exist; they would like to see orders for bamboo products attached to proposals for loans. They want reasons for acquiring loans to be well stated. Banks want a feasibility study data, good credit record from applicants and good business plans in order to grant loans. Some respondents explained that it is difficult to grant loans for plantations because of imminent fire hazards; proposals should explain how fire can be prevented.

If loans granted to farmer cooperative groups, it would be easier to retrieve them. District assemblies are perceived to be more responsible in handling loans, and most financial institutions would rather prefer district assemblies to take loans and establish plantations. The Bank of Ghana is requested to offer loans to the Agricultural Development Bank at low rates to ensure that investors are charged lower interest rates. Banks normally offer loans to investors who are willing to invest in value-added products. It is helpful if investors have technical know-how in the field they want to invest in. Business proposals should clearly state that bamboo processing is a value-added activity and that the necessary skill is available.

Some respondents have appealed to banks to improve their terms for loan disbursement e.g., giving long-term loans. “There should be investment banks; there are no serious investment banks; they are all going commercial”, lamented one respondent.

Credit and Subsidies for Plantation Owners

The government has been petitioned by some institutions to include bamboo in the forest plantation development project underway in the forestry department; planting materials and money for clearing planting sites are given out free. The forestry commission could supply free seedlings and other inputs to plantation owners to help initiate the program. The credit departments of banks should provide subsidized inputs to farmers and other investors. The Ministry of Agriculture has a key role to play in input supply. Credit in the form of inputs and services especially for out grower schemes could be helpful. The government may create depots for farmers to sell their harvested bamboo. Banks are urged to support environmental related businesses such as bamboo utilization as a way of demonstrating their corporate social responsibility.

Some institutions believe that district assemblies and cooperatives should have better chances in acquiring loans as they are more likely to put the money to the intended use. They are also more likely to pay back. It was noted that some individuals have borrowed money from the Forestry Commission but have defaulted. Farmers who do not earn regular income should not be given loans, suggested some respondents. Others think that whoever has a good proposal and the expertise, and can pay back should be able to procure a loan. Fairness is advocated and nepotism is condemned.

Research

The government should provide funding to researchers adequate to undertake rigorous research and provide information needed by investors. As a policy, researchers need to be paid well by the government. Their research results need to be implemented. To ensure adequate dissemination of research results it is advised that the government mandate researchers to circulate summary results to companies and other relevant stakeholders. Results should be published widely in journals, newspapers, the Ghana gazette, and other relevant media. A research board should oversee studies related to improving bamboo utilization.

The bamboo species in Ghana are not appropriate for commercialization and are vulnerable to insects. Researchers are being urged to investigate ways of improving the fiber quality of the local bamboo species for commercial utilization. They should engage in product development and determine the best way for bamboo processing and seasoning. Researchers should recommend the best species and their uses, types of species and site-species matching. They should provide information on cost-benefit analysis, seed growth, tending, thinning and processing. Researchers are requested to provide recommendations for good management practices for natural stands and plantations of bamboo.

Researchers are urged to effectively collaborate with one another, the industry and relevant institutions such as Bamboo and Rattan Development Program (BARADEP) and INBAR. Some respondents advocate that the private sector pay for research since it is purported to be a major beneficiary of research results.

Extension and Technical Service

Many institutions need extension personnel who can collaborate with sister institutions to disseminate information. Using existing extension personnel to their full capacity is recommended. Upgrading their skills by the forestry commission to promote bamboo is also important. New technical personnel also need to be trained to complement the efforts of existing personnel. Special training could be given to a group of researchers who would teach the industry's affiliates e.g., TIDD, GTA and GTMO about bamboo utilization. To adopt bamboo, one respondent suggested that a technical course be created and taught in the Junior and Senior secondary schools in Ghana. A course should be taught to students enrolled in relevant programs at the universities institutions. The Bamboo and Rattan Development Program should be ready to provide information about bamboo to interest parties.

Marketing

Institutions responsible for investment and marketing of forest products (e.g., TIDD, GEPC, GIPC and AGI) should develop coordinated marketing strategies that increase bamboo utilization. This will include building trade relations with market leaders of bamboo products. The manufacture of good quality products, development of Ghana bamboo brand with distinguishing qualities, attractive pricing and excellent packaging of products to meet international standards are prerequisites to market success. Relevant institutions are urged to

have information about the types of products that can be made from bamboo, the uses to which they can be put, the countries that may buy the products and the existing marketing channels.

The TIDD is urged to include bamboo as a new material in its marketing activities and help establish grading standards for bamboo. The TIDD can collaborate with countries that manufacture bamboo products and obtain the appropriate bamboo grading rules for use in Ghana. Many respondents suggested that environmental NGOs assist in finding markets for bamboo products. Industry associations e.g., FAWAG, GTMO and GTA should get involved in developing markets for bamboo and bamboo products. To increase awareness bamboo, respondents suggested that the government be encouraged to use bamboo products in new government buildings such as secondary schools and hospital buildings. Most of these buildings could be mandatorily floored with bamboo floorings and furnished with bamboo furniture. An example of this is already underway in some forestry commission offices and relevant departments in tertiary institutions.

District assemblies could to supervise public building construction contracts and ensure that bamboo is used as a construction or furnishing material. This form of promotion could increase public awareness ensure diffusion. The government can encourage the public through various communication channels to use bamboo. Discussions on the television and radio about bamboo can be an effective means of communicating to the public about the importance of bamboo. Television, radio, and face-to-face educational programs should be appealing to orient public opinion that bamboo products compare well with wood products. The successful adoption of bamboo would depend on the degree to which public opinion about bamboo becomes more positive.

Trade shows such as the one organized by the forest products industry, i.e. the Ghana International Furniture and Woodworking Industry Exhibition (GIFEX) is an effective way of promoting bamboo and bamboo products. At such events, bamboo products could be showcased and brochures containing sample photos and product use given out to participants.

Value-added processing should be mandated, said some respondents. Some of these products which are tertiary products include furniture, cabinets, moldings and flooring. Panel products such as plywood and laminated products are suggested. Minor products, e.g., matches, toothpicks and handicrafts are also important. Bamboo shoots are an important niche market in Ghana.

Heads of institutions want the government to summon architects and developers to specify the use of bamboo in government buildings. They also propose that all tourist sites including hotels should use bamboo products. The beauty of these products should overshadow the inferiority commonly associated with bamboo. Some respondents recommend that products be made to meet market demand. To create demand, products can be made on trial basis for institutions to exhibit.

Exports and Imports

To further increase bamboo processing opportunities, respondents suggested no price premiums for bamboo pole export. Bamboo should be processed before being exported. Quality assurance and packaging of bamboo products will help increase sales. The TIDD was encouraged to set up internationally recognized grading rules and quality standards for processing.

Some have suggested that, allowing imports of bamboo would help the companies and consumers to familiarize themselves with products before the country starts manufacturing.

Bamboo is a non-traditional product so exports to other countries are not taxed. As a motivation, imports of bamboo processing machines could be waived of tax. Ghana currently has quality problems with wood furniture exports so exporting bamboo products would require efforts from the government, researchers, the industry and other stakeholders, said an industry association representative.

To ensure that respondents are able to effectively communicate with stakeholders, they were asked to state the communication channels they usually employ. This is presented in the next section.

Effective Means of Communication with Industry

Relevant institutions are deemed the appropriate bodies that have to relay important information to the industry. To determine communication strategies with best potential for far reaching impact, respondents were asked to identify effective communication methods. Several channels of communication, with appropriate information are believed to effectively deliver the bamboo message to the industry and other stakeholders (**Table 5.10**). These means of communication are used in Chapter 6 to propose appropriate strategies for awareness creation about bamboo.

Table 5.10: Effective Means of Communication between Institutions and the Industry

- Direct visits to industry, entrepreneurs
- TV and radio, radio talk show, mobile vans with microphones, DVD
- Meetings and discussion with heads, stakeholder meetings for dialogues, reports, presentations, phones, seminars, lecture series, workshops
- Direct mail (letters, documents)
- Printed media, technical information sections, news papers, publication, periodicals, manuals, handbooks, journals, industry bulletin, brochures
- Training centers e.g., WITC, and labs of universities and research institutions
- Research interviews
- Electronic media (Internet, email)
- Interaction with the press, press releases
- Documentaries on funded projects
- Public relation outreach
- Showrooms, flyers, trade fairs e.g., GIFEX, trading programs
- Ministries, government
- Chiefs and local government
- Training employees, teaching curriculum

Conclusions

This chapter focused on the institutions that may be relevant to a program to promote the adoption of bamboo in Ghana's forest products industry. Thirty two heads of institutions were canvassed during the study to determine barriers and needs in promoting the adoption of bamboo by the industry. Data were collected through closed-ended and open-ended questions to address the research questions and objectives.

Several barriers of great importance to the adoption of bamboo were identified. Gaps exist between the resources that institutions can offer to the industry now and what they would like to offer in the future. The most important gaps found were in providing public awareness and expertise. Lack of adequate funding was found to be the most important barrier to

researchers' efforts to perform research. This suggests that research data may not be available until the government supports researchers with funding. Institutions do not have facilities where the industry can observe bamboo processing. They also lack marketing and policy information about bamboo. Institutions confirmed that they should be responsible for filling some industry needs. Meanwhile, the institutions themselves have their own barriers to circumvent and needs to meet.

As a first step, the government should equip the institutions. Research institutions need to be exposed to current bamboo technology through training, and supported so that they can determine the best commercial species and products. This may imply sponsoring selected researchers to attend training programs in countries such as China where bamboo technology is advanced. Ghana would gain if it engaged in a bamboo promotion program to help meet the Millennium Development Goals. Seeking capacity building and investment assistance from international organizations such as the World Bank, the UN, FAO, ITTO, INBAR, DFID, and USAID and development NGOs could ensure that institutions are ready to promote the use of bamboo in Ghana.

Once institutions have attained adequate knowledge about bamboo, they should disseminate the information to the industry. Institutions are urged to help the industry to circumvent their barriers by providing the necessary training, awareness, facilities for training, and promotion of bamboo. To create awareness, the government should encourage the use of quality bamboo products in public places such as schools, hospitals, government offices, hotels and tourist centers to position it better in the marketplace. Institutions are perceived to be the external change agents who will persuade the industry to adopt bamboo as a supplement to the dwindling timber resource. Hence, in creating awareness, they have to elucidate on the benefits

(e.g., adequate raw material, job security, corporate social responsibility) of using bamboo to the industry as opposed to wood.

To ensure successful marketing of bamboo products, marketing channels have to be identified. Importers and buyers of bamboo products need to be contacted by the Timber Industry Development Division (TIDD) to establish markets in both the US and Europe. Institutions should disseminate the potential necessary information for products through workshops, seminars, training, lecture series, meetings and direct visits. Besides, bamboo manufacturers in Asia should be identified with the help of INBAR, TIDD, and the Ghana Export Promotion Council to establish marketing links. Bamboo products manufactured in Ghana must be of consistent good quality and packaged well enough to meet international standards.

Some institutions which play important roles in removing the barriers to industry's adoption of bamboo include the banks (for long-term finance), the Forestry Commission (for research funding, marketing, training, policy formulation), relevant educational institutions (for research and training) and the Ghana Export Promotion Council (for exports). Policy revision or formulation must adapt land use, plantation management and ownership so that entrepreneurs are encouraged to grow more bamboo. Extension of bamboo growing and processing as well as utilization of bamboo products and exports is critical. The government is urged to collaborate with INBAR to develop policies that would address all these issues. Community ownership of plantations by district assemblies should help ensure better managed plantations, help protect plantations from bush fires, and lead to better willingness for banks to grant loans for plantation management.

References

- Aldridge, A. and K. Levine. 2001. *Surveying the Social World: Principles and Practice in Survey Research*. Open University Press. Buckingham, Philadelphia. 196pp.
- Alreck, P. L. and R. B. Settle. 2004. *The Survey Research Handbook*. Richard D. Irwin, Inc. USA. 463pp.
- Dillman, D. A. 2000. *Mail and Internet Surveys: The Tailored Design Method*. 2nd Edition. John Wiley & Sons, Inc. 464 pp.
- Eliasson, G. 2001. *Economic Role of Technology in a Competence Bloc Based Industrial Policy Analysis*, In: Sweeney, G. (Ed.) 2001. *Innovation, Economic Progress and the Quality of Life*. Edward Elgar Publishing Inc., UK. 182pp.
- Feldman, M. P. and N. Massard. 2002. *Location, Location, Location: Institutions and Systems in the Geography of Innovation*, In: Feldman, M. P. and N. Massard (Eds.), *Institutions and Systems in the Geography of Innovation*. Kluwer Academic Publishers, London. 365pp.
- Hage, J. 2005. *Organizations and Innovations: Contributions from Organizational Sociology and Administrative Science*, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems*. Edward Elgar Publishing Ltd., UK. 307pp.
- Houtkoop-Steenstra, H. 2000. *Interaction and the Standardized Survey Interview. The Living Questionnaire*. Cambridge University Press. 209pp.
- Kent, R. 2001. *Data Construction and Data Analysis for Survey Research*. Palgrave Publishers Ltd., New York. 251pp.
- Neuman, W. L. 2003. *Social Research Methods: Qualitative and Quantitative Approaches*. 5th Edition. Pearson Education, Inc. 584pp.
- Porter, M. E. 1990. *The Competitive Advantage of Nations*. The Free Press, New York. 855pp.
- Porter, M. E. and S. Stern. 2002. *Innovation: Location Matters*, In: Roberts, E. B. *Innovation: Driving Product, Process and Market Change*. Jossey-Bass, CA. 343pp.
- Rochlin, D. 2006. *Hunter or Hunted? Technology, Innovation and Competitive Strategy*. Thompson Higher Education. Ohio, USA. 306pp.
- Smith, S. M. and G. S. Albaum. 2005. *Fundamentals of Marketing Research*. Sage Publications, Inc. California, USA. 881pp.

Waarden, F. 2005. A Prototypical Institution: Law, Regulation and Innovation, In: Casper, S. and F. Waarden (Eds.), *Innovation and Institutions: A Multidisciplinary Review of the Study of Innovation Systems*. Edward Elgar Publishing Ltd., UK. 307pp.

CHAPTER 6: CHANGE MANAGEMENT MODELS FOR ADOPTION OF BAMBOO IN GHANA'S FOREST PRODUCTS INDUSTRY

Introduction

This chapter uses the results presented in previous chapters with relevant themes from innovation and change management literature to develop models for the adoption of bamboo in Ghana's forest products industry. First, a literature review in innovation and change management specifically the ADKAR (Awareness, Desire, Knowledge, Ability and Reinforcement) model suggested by Hiatt (2006) is presented to set the basis for inferential synthesis of the results in Chapters 3, 4 and 5 to develop conceptual models of change for the industry.

As shown in **Figure 2.3**, the study variables were obtained from the perceived attributes of innovation. These attributes are the relative advantage of innovation, the innovation's compatibility with current processes, its complexity, trialability and observability (Kotler et al., 1999; Rogers 2003). The questions used in the interviews were developed based on these attributes. The attributes are perceived as barriers or needs if they inhibit the diffusion of the bamboo technology. The objective for this chapter is to develop change management models to assist the government, industry, policy makers and industry associations in ensuring the successful adoption of bamboo in Ghana's forest products industry. The models serve as interventions that all stakeholders may have to follow in order to facilitate the bamboo adoption process.

Literature review

Innovation and Change Management

For the purposes of this study, change is defined as the continuous process of an organization's attempt to align itself with shifts in its marketplace and with the realities of its external financial, physical, social, political, and technological environment (Brinberg et al., 2008; Evans and Schaefer, 2001). Change management is defined as the modification and transformation of organizations so they may maintain or improve their effectiveness (Cameron and Green 2004; Hayes, 2002). To remain competitive in the forest products industry, firms implement changes in many operational aspects including labor, land, manufacturing, marketing, supply chain, business strategies, staffing requirements or technology (Hansen et al., 2002; Baldwin, 1984; Thurbin, 2001; Brinberg et al., 2008).

Implementing change in organizations is difficult because organizations are complex and composed of people with varying inclinations and expectations (Holbeche, 2006; Evans and Schaefer, 2001; Eccles, 1994). The ADKAR model proposed by Hiatt (2006) is a simplified way to implement complex changes and seems most appropriate for this study. This model helps to develop strategies for the change from wood to bamboo utilization in Ghana's forest products industry. The tenets of the model are believed to help diffuse the bamboo adoption initiative and steepen the S-shaped curve of adoption in the early stages of diffusion. In short, the implementation of change is more sanguine of success if there is much awareness about the change, and the adopting target group has desire and the required knowledge and ability to implement it, in addition to the flair to reinforce it. The ADKAR model is further explored in the next section. Key findings in the study are integration with the factors that influence people's

behavior with respect to the ADKAR model to develop final adoption framework for the industry.

Awareness

Awareness knowledge gives information about the existence of an innovation (Ljungberg, 1982; Rogers, 2003). Awareness about the need for change explains one's comprehension about the nature of the change that is underway, why the change is being implemented and the risk of not changing (Dupuy, 2002; Hayes, 2002; Rogers, 2003; Hiatt, 2006; Streebel, 1998). The internal and external factors that created the need for change and the benefits for changing are also important in the awareness creation process. This is supported by the resource-based view (RBV) of the firm which postulates that some companies perform better than others because of the differences in their internal resources (Bonsi, Gnyawali and Hammett, 2008; Barney, 1991; Hitt et al., 2007; Dollinger, 2003). This implies that the improper creation of awareness based on how companies deploy resources may increase resistance to change (Holbeche, 2006; Hiatt, 2006; Hultman, 1998; Streebel, 1998).

Awareness knowledge may encourage an individual to seek further information about the innovation i.e. "how to" knowledge (Bonsi, Gnyawali and Hammett, 2008; Shields, 2006; Hiatt, 2006; Sweeney, 2001; Acs and Audretsch, 1991). Change agents¹⁴ normally desire to speed up the process of innovation adoption. To achieve this, they strive to convey information about new ideas in a more accurate and quicker way and shorten the innovation-decision process time after people have become aware of a new idea (Rogers, 2003). This study determines appropriate ways to disseminate this message.

¹⁴ Individuals who influence the innovation decision clients (There two types, i.e., external, e.g., extension agents, politicians, consultants, researchers, and; internal, e.g., board of directors, CEOs, managers and supervisors).

Communication channels are the means by which messages (innovations) are transferred from one person to another and must be selected carefully (Mahajan and Peterson, 1985; Rogers, 2003). The quickest way to reach a large audience is through the mass media (i.e. radio, television, newspaper etc). However, interpersonal channels are more effective in conveying the message and convincing society to embrace new ideas especially if the parties involved have common backgrounds or interests, e.g., education, or socioeconomic status (Eliasson, 2001; Rogers, 2003).

The whole innovation process can be viewed as a complex network of communication paths that link the various stages of the process (Hayes, 2002; Ljungberg, 1982). A conglomeration of companies facilitates flow of information and diffusion of innovation (Feldman and Massard, 2002). Within a firm, communication between change agents, e.g., managers and employees has to be effective to successfully implement a change. Workers need to be informed about the intricacies of a change and motivated to adopt the change (Holbeche, 2006; Hayes, 2002; Streebel, 1998). Interactive communication channels such as the Internet are also gaining much importance in disseminating information. At any given time, a sizeable number of potential adopters become informed about certain innovations but not enthusiastic about their adoption (Rogers, 2003; Hiatt, 2006).

Desire

Once there is recognition of the need for change usually there can be desire for change (Hayes, 2002). Desire, the second element of the ADKAR model is the level of motivation of a potential supporter of a change and their eventual choice to adopt the change (Hiatt, 2006; Hayes, 2002). While there may be awareness about the benefits of a change, there may not be the desire to accept it. Desire creation is a complicated process because it is difficult to influence

people's choices. To facilitate change it is important to understand the factors that influence people's urge to desire or fail to desire a change. These factors include the nature of the change and its benefits, the organizational or environmental context of the change, the individual's personal situation and what motivates the individual (Hiatt, 2006).

Generating desire to change in employees who will implement the change is important and helps prevent potential resistance to the change (Holbeche, 2006; Hultman, 1998; Streebel, 1998). Absorptive capacity, a firm's ability to value, assimilate and commercially use new external knowledge and predict future technological advances may be a basis for a firm's motivation to a change (Todorova and Durisin, 2007; Lane et al., 2006). This implies that the richer the knowledge pool is in improving the efficiencies of existing technologies, the greater will be a firm's motivation to invest in R&D (Bonsi, Gnyawali and Hammett, 2008; Lane et al., 2006). The perceived attributes of an innovation in the form of its relative advantage, compatibility, complexity, trialability/divisibility and observability/communicability are of great importance in developing desire to adopt an innovation (Kotler et al., 1999; Rogers, 2003). Individuals weigh possible present or future consequences of an innovation before adopting it. They seek innovation evaluation information that helps them to reduce uncertainty (Holbeche, 2006).

Knowledge

Knowledge, the third element of the ADKAR model explains how to implement a change. Knowledge includes training and education on the skills and behaviors required for the change, well-explained information about how to use new processes, systems and tools, and comprehension of the new responsibilities that come with the change (Evard and Gipple, 2001; Goel, 1999; Hiatt, 2006; Sweeney, 2001; Acs and Audretsch, 1991).

The factors that influence the possibility of attaining knowledge in the ADKAR model include the current knowledge base of the potential adopter, the potential of the individual to gain additional knowledge, the resources available for education or training, and the access to, or the existence of the needed knowledge (Hiatt, 2006). Having adequate knowledge base is an indication that adopters may be able to manage the bamboo adoption process successfully. Knowledge in the form of management, manufacturing, technical expertise, and customer service improves firm performance and can be a source of sustained competitive advantage (McBurney and Millen, 2008; Bonsi, Gnyawali and Hammett, 2008; Korhonen, 2006; Bontis et al., 2002; Grant 1996). As these authors noted, one of the most important inputs in production and primary source of value is knowledge (Bull and Ferguson, 2006; Grant, 1996).

“How to” knowledge provides information about how to use an innovation correctly (Rogers 2003; Sweeney, 2001; Acs and Audretsch, 1991). “Principles” knowledge is the information about the functioning principles underpinning the operation of the innovation, e.g., the mechanism that explains the mechanical behavior of bamboo (Rogers, 2003; Sweeney, 2001; Acs and Audretsch, 1991).

“Principles” knowledge enables individuals to understand and judge the superiority of an innovation. However, a good number of organizations adopt innovations without “principles” knowledge. Change agents are very important in ensuring that clients obtain all these kinds of knowledge (Sweeney, 2001). Historical success translates into future success (Lahtinen, 2007; Korhonen and Niemelä, 2005; Henderson and Cockburn, 1994; Dierickx and Cool, 1989). To address current issues, the mental models of managers that are no longer potent need to be discarded and new models developed (Gnyawali and Stewart 2003; Barr et al., 1992). In that respect, the mental models of managers that have potential to gain additional knowledge undergo

the stages of unfreezing/unlearning, change, and refreezing. In the unfreezing/unlearning stage, old beliefs are discarded and a way is given for new comprehensions; this process nurtures and protects core competencies (Prahalad and Hamel, 1990). In the freezing phase, newly gathered knowledge solidifies (freezes) (Bonsi, Gnyawali and Hammett, 2008; Korhonen, 2006; Barr et al., 1992). Firms that have attributes as these may be able to accept bamboo as a raw material.

Ability

The fourth element of the ADKAR model defines the demonstrated capability of potential adopters to institute change and attain satisfactory results. If a manager who is willing to implement change has awareness, desire and knowledge about an innovation but does not have the requisite resources to implement the change, the objective cannot be met (Hiatt, 2006). According to Brinberg et al. (2008), change in the forest products industry must be accompanied by innovative business functions and adaptability. To successfully implement a change, the factors that influence the ability of potential adopters to adopt have to be known. These are psychological blocks to change, physical abilities, intellectual ability, the availability of time for developing the necessary skills and the availability of resources to support the development of new abilities (Acs and Audretsch, 1991; Streebel, 1998; Ludolph, 2006; Hiatt, 2006). An example of a psychological block is the current poor perceptions about bamboo in Ghana. Resources may be tangible (e.g., physical goods such as land, machines, buildings, inventory, and money) or intangible (e.g., brand names, knowledge and reputation) (e.g., Amit and Schoemaker, 1993; Barney, 1991; Peteraf, 1993; Hitt et al., 2007; Hill and Jones, 2004).

Reinforcement

The last element of the ADKAR model involves any action or event that helps to consolidate and reinforce the change that has been implemented. Several factors are important in reinforcing a change. Some of these include the extent to which the reinforcement makes sense to adopters, the association of the reinforcement with actual demonstrated progress or accomplishment, the absence of negative consequences and the accountability systems to reinforce the change (Cameron and Green, 2004; Hiatt, 2006; Shields, 2006). These elements of the ADKAR model are used to further discuss the results of this study. In the next section, the models for change management in the bamboo adoption process in Ghana's forest products industry are developed and discussed.

Models of Change and Innovation Management

Interpretation of the survey results help in understanding the barriers that impede efforts by the industry and institutions to encourage bamboo adoption. Some of these indicate the innovativeness of the respondents and their level of readiness in adopting the change. The results have also helped in determining the barriers that need serious attention.

Figure 6.1 provides a framework that summarizes the points of interventions that would help in implementing the change (bamboo adoption) successfully in Ghana's forest products industry. The most important points of intervention are included in the ADKAR framework. Each element of the framework is explained in detail as the discussion progresses. **Figure 6.1** only summarizes the five elements. Change agents may create awareness through documentaries and workshops and encourage desire by providing information about the benefits of using bamboo.

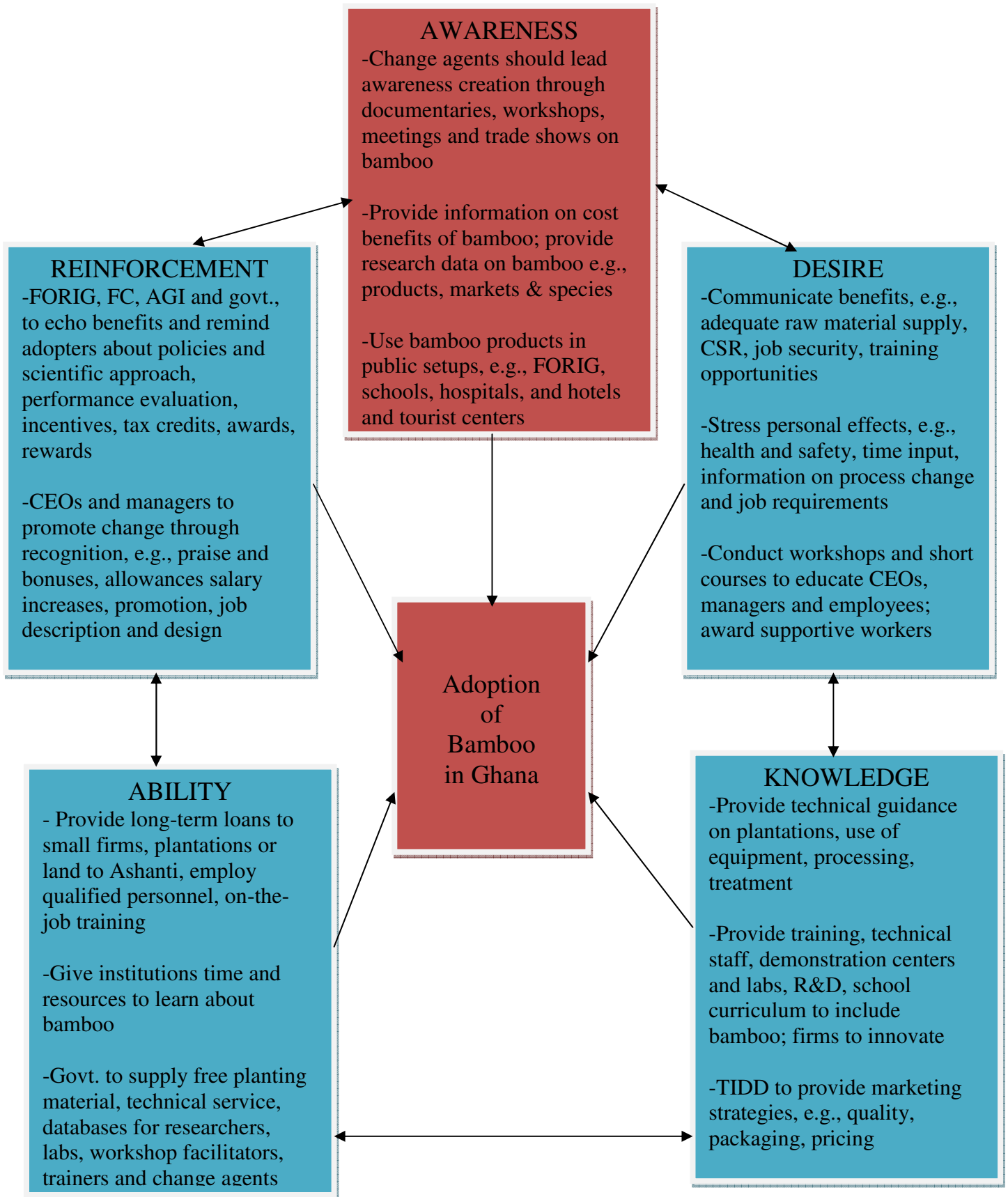


Figure 6.1: Overall Change Management Model for Adoption of Bamboo by Ghana's Wood Industry

Knowledge may be created through training, and ability increased through the supply of adequate resources to the forest products industry, employees and the institutions. Reinforcement of the change must be done through performance appraisals and rewards. A detailed discussion of the models is intertwined with the results of the interviews conducted.

Awareness as the Results Depict

The discussion in this section is presented using the results of the study in conjunction with the literature review and the factors that influence awareness creation. **Figure 6.2** illustrates the model for awareness creation for the successful adoption of bamboo in Ghana's forest products industry. The left side of the model contains the factors identified from the study that influence awareness creation about bamboo in Ghana.

While certain initiatives have been taken to address some of the factors that impact awareness creation, other factors need serious attention. The acronyms DTSE i.e., 'done to some extent', and NSA i.e., 'needs serious attention', indicate the current nature of the problems; the points of intervention are shown on the right side of the models. The discussion of the model begins with respondents' perception about the current situation and their awareness about the change and its nature. **Tables 4.14 and 4.17** in Chapter 4 show some results about awareness that were gathered from respondents and will help in this discussion.

Perception about the Current Situation and the Awareness about the Change

The perception about the current state of affairs in Ghana's forest products industry is important in determining the level of awareness and whether adoption of bamboo is important in the industry.

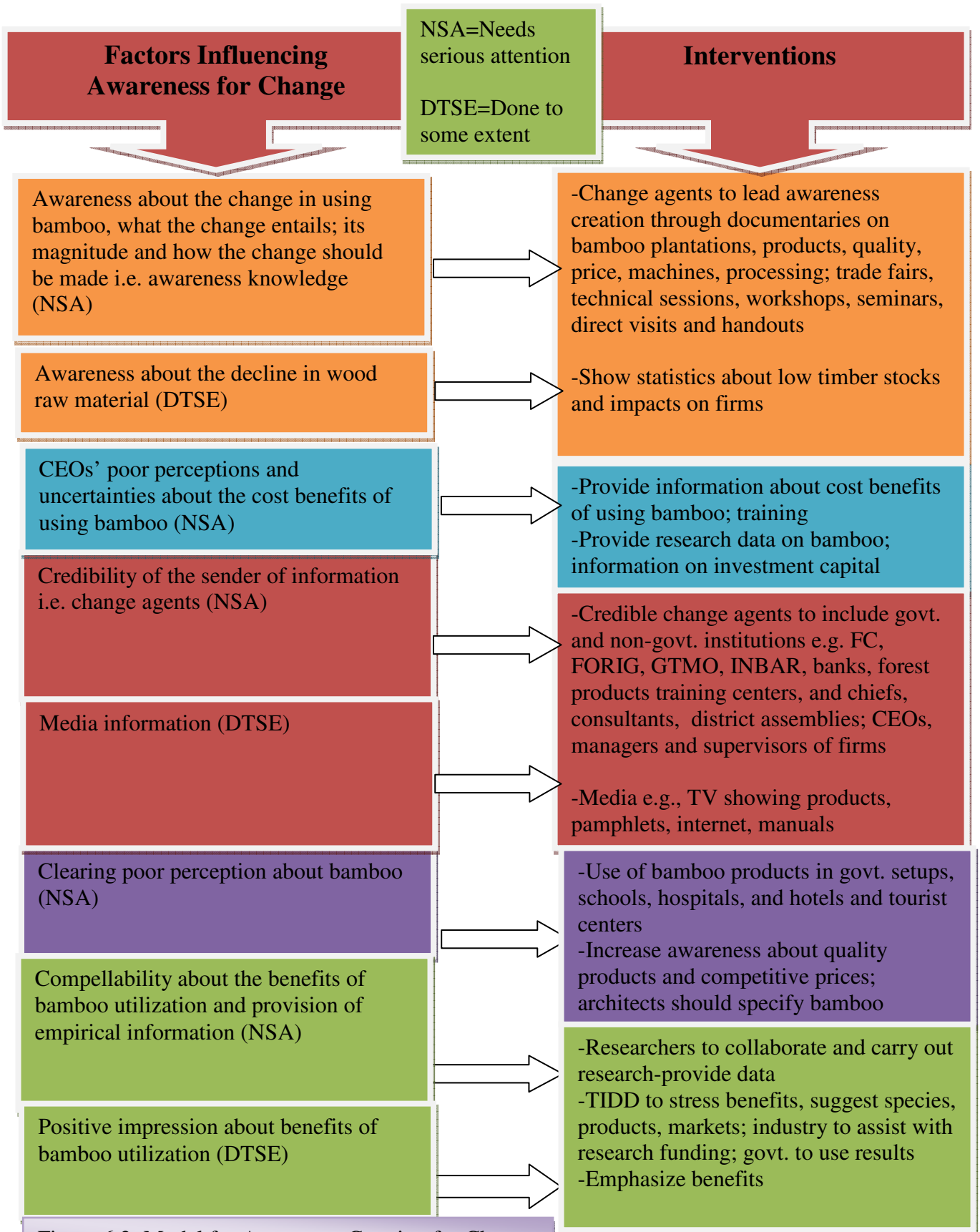


Figure 6.2: Model for Awareness Creation for Change

In the process of administering the questionnaires for this study, some awareness was created. Change agents may use some of the information in this study to create the needed awareness and desire.

To begin, the level of awareness that supplies of timber raw materials are declining was assessed. As shown in **Table 4.14** of Chapter 4, all respondents are realize that, the industry is facing timber raw material shortages and that an action is needed. This response is substantiated by the results presented in Chapter 3 which imply that, the declining raw material base impacts the industry. **Figure 3.2** of Chapter 3 shows that, raw material availability and cost have risen by 34% in the past five years, indicating raw material scarcity. In addition to procurement difficulties, quality of the raw material has declined. So as shown in this model, it is known to some extent (DTSE) that the wood raw material is becoming scarce. This knowledge helps in the efforts to introduce an alternative raw material or create awareness. It was evident in the data collection process that some respondents were eager and excited to hear about initiatives to safeguard their businesses with alternative fiber materials.

Although most companies canvassed knew there is a raw material shortage, some never thought or knew that bamboo could serve as a substitute material. Much information has not been provided by change agents to sufficiently convince the industry so that they would adopt bamboo. As a point of intervention, external change agents especially the Forestry Commission, the Forestry Research Institute (FORIG), the Ghana Timber Millers' Organization (GTMO), the International Network for Bamboo and Rattan (INBAR), and the Bamboo and Rattan Development Program (BARADEP) and district assemblies should help create awareness through workshops, seminars, direct visit, research as this study, the mass media and all other effective means of communication presented in **Table 5.10** of Chapter 5.

A “yes” response of 65.4% in **Table 4.14** showed that the industry’s respondents know that bamboo is being used as a raw material especially in the furniture industry. As shown in **Table 4.17**, more than 50% of the industry’s respondents believe that at least seven commercial products can be made from bamboo. About 96% of the CEOs believe that an alternative natural fiber material is needed to supplement natural timber. It appears that respondents see the risks of not changing to be high. For example, they believe that the use of bamboo is associated with lower raw material costs and higher raw material availability in comparison with wood. From these perceptions, it is clear that respondents see the adoption of a new fiber material to supplement the dwindling wood raw material to be in the right direction.

However, as the results show, respondents have little or no information about the nature of the change itself and its magnitude. With reference to **Table 4.19**, lack of information about the change, i.e., products, machines, processes, cost, markets and the raw material is the most important barrier perceived by industry CEOs. In addition, **Table 5.4** in Chapter 5 shows a gap of 83.3% for awareness creation. There is awareness about the need for change but little information about the change itself, what it entails, its enormity and how it can be implemented is available.

Change agents should increase awareness through workshops, seminars, direct visits, handouts, technical sessions and trade fairs. Documentaries on bamboo plantations, machines, processing, products, quality and price would be helpful in informing potential adopters about the change. Companies that use bamboo should be showcased in the media to help create awareness about bamboo. The Forestry Commission should collect and provide current statistics about low timber stocking volumes to see the magnitude of raw material scarcity, and the need for fast growing alternatives.

CEOs' Perceptions about Problems

Figure 6.2 indicates that CEOs' perceptions may impact the adoption of bamboo. The manner in which people perceive problems determines how effectively awareness can be created. The perception about decline in raw material supply in Ghana's forest products industry is not recognized at the same magnitude among CEOs. For example, some companies do not see the acute shortage of raw material in the industry to be a problem. They have adequate raw material from their own plantations and concessions. The companies with abundant raw material have some favorable internal capabilities but are failing to take advantage of their efficiencies to aggregate asset stocks toward achieving sustained competitive advantage. Thus, these companies have shown little interest in raw material diversification. They seem to know little about the seriousness of the current situation. However, the perceptions of the CEOs of these companies can neither be described as positive nor negative because there is little information about bamboo and there is little evidence about its success as a raw material.

Most companies perceive the shortage of raw material to be detrimental to the industry's future. However, majority are not sure about the cost benefits of using bamboo, which is not a favorable perception. In addition, many Ghanaians perceive bamboo to be an inferior material that is used only for pedestrian purposes. For intervention, it is important for institutions to provide information about the cost and environmental benefits (with reference to the Natural Capital Strong Sustainability Theory) of using bamboo. Change agents should provide research results free of charge to potential adopters. Information on the magnitude of the required investment capital including machines, plantations and human capital should be readily available to institutions which will diffuse this to the industry.

The Credibility of the Sender

The credibility of the people who convey information about an innovation has an impact on the degree of awareness creation. There have been some efforts to inform the public about the need for bamboo utilization. Some reports and documentaries have been presented on the TV about bamboo. Mass media is an effective communication tool for disseminating information about bamboo. However, there still is a big gap to fill.

No major initiative has been taken by change agents to present a case for bamboo utilization. There is the need for credible change agents to reach potential adopters to create awareness about bamboo. Using credible change agents e.g., government and non-governmental institutions, banks, educational institutions, chiefs, consultants, the Wood Industry Training Center, district assemblies, chief farmers and opinion leaders, would be the first step to facilitate effective flow of the necessary information about bamboo. Within firms, credible change agents include CEOs, board of directors, managers, supervisors and team leaders. They have to explain the purpose of the change, its benefits and how it should be implemented to others at the firm. Using these credible agents would also prevent resistance to change.

Overcoming Poor Perceptions about Bamboo

Circulation of wrong information about bamboo will slow the pace of awareness creation. There is a poor perception about bamboo in Ghana. As the results show in **Table 4.17**, the most common products made from bamboo are furniture and handicrafts. These products are purchased by only a small group of people. As a way of creating positive awareness about bamboo utilization, there is need to change the poor perceptions about its products through proper education.

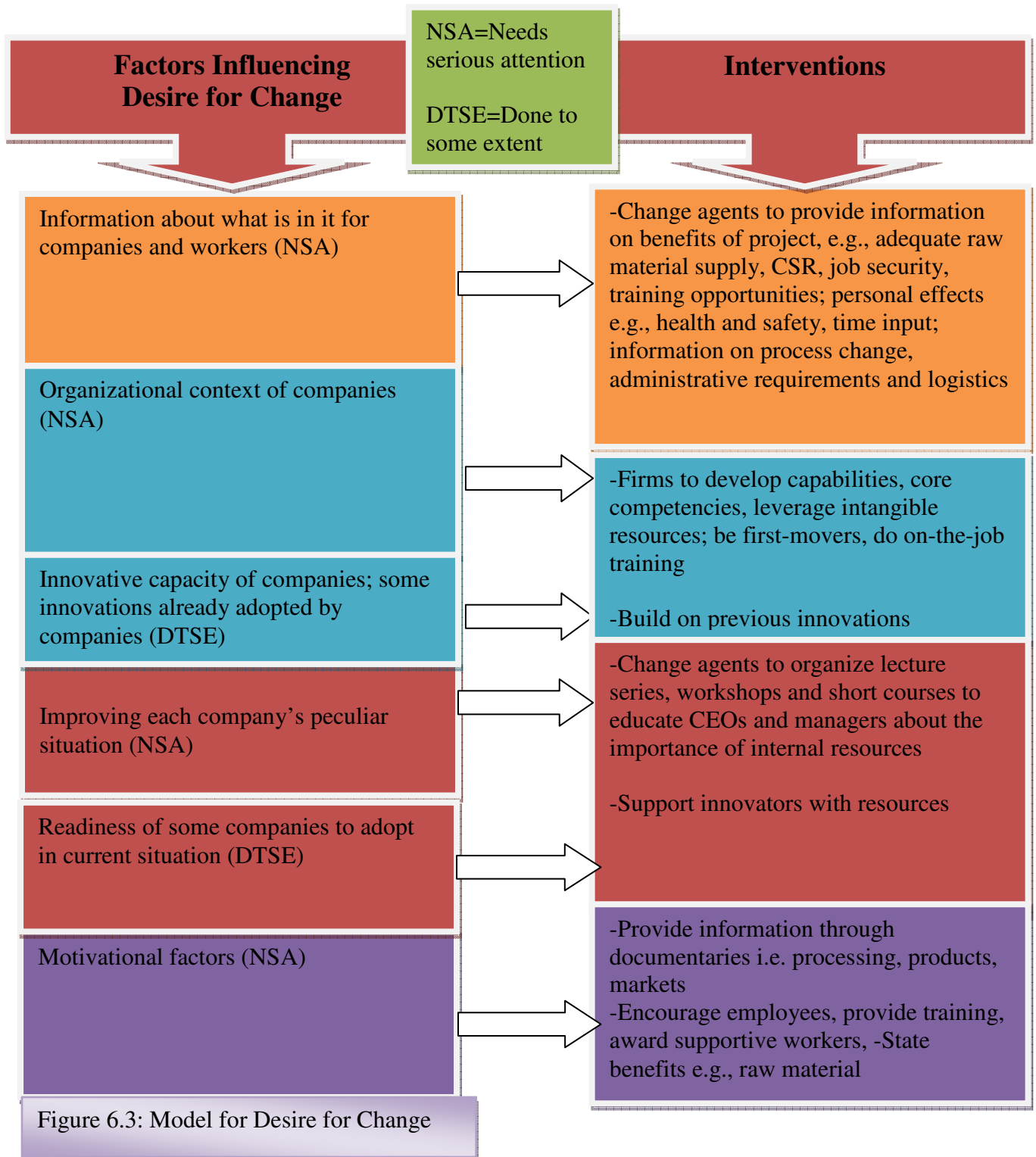
As an intervention, the use of bamboo products by institutions, e.g., the Forestry Commission, FORIG, schools, hospitals, and hospitality centers such hotels and tourist centers could create a good impression about the product. Positioning bamboo as a quality and price competitive product would enhance its reputation. If architects start specifying bamboo products, contractors and estate developers would begin to appreciate their usefulness and convince their clients to purchase them.

Compelling the Industry to Use Bamboo

A compelling case has not been made for bamboo utilization in Ghana. Adequate information about bamboo is lacking and benefits of using bamboo are not well known. There is little or no cost benefit analysis as one could compare bamboo to wood. Although some industry respondents believe that there are several cost savings in using bamboo, there is no empirical information that substantiates this. It is imperative that researchers collaborate in research with other partners both in Ghana and abroad, provide information to the industry about bamboo and emphasize its economic, environmental and social benefits. The advantages of using bamboo over wood and strategies for effective marketing of bamboo products need to be developed and disseminated.

Desire as the Results Depict

The desire of the respondents to adopt bamboo is discussed in this section in conjunction with the results and the factors that influence respondents' urge to adopt the new material. The model for desire is shown in **Figure 6.3** and explained in the following discussion.



The Nature of the Change and what is in it for Companies and Workers

Knowing the nature of the change and the benefits therein are important catalysts that provoke desire in potential adopters. It is obvious from the respondents that information about the nature of the change is lacking and makes adoption difficult. There is little information about the benefits of using bamboo. Although some respondents realize possible benefits such as readily available and cheaper raw material, there is little information quantifying the benefits of adopting bamboo. The point of intervention is that change agents should provide information on the benefits derived from bamboo utilization e.g., adequate raw material supply and the ability to ensure corporate social responsibility (CSR), i.e., maintaining the environment, sustaining the industry and securing jobs.

Companies and workers should be informed about the training opportunities that they may obtain in the adoption process. They should know from change agents about the nature of the change, e.g., health and safety requirements, time input, information on process change, administrative and skill requirements, logistics and all other requirements in the production chain.

The Organizational or Environmental Context of the Change

The organizational or environmental context of the change is an important factor that facilitates desire in adopting change. The adoption of bamboo in Ghana's forest products industry is an initiative that will not be carried out solitarily. It is a whole industry initiative that may be accepted on a large scale. From the results in Chapter 4 **Table 4.16**, it is clear that most companies are willing to adopt bamboo provided the barriers are limited. It is common that companies adopt once leaders in the industry succeed with adoption. Nevertheless, the degree to which innovations have succeeded in the industry and in a particular company can affect one's

decision to adopt. The forest products industry in Ghana has seen some form of innovation. For example, as seen in **Table 3.4** in Chapter 3, many companies have moved from primary and secondary processing to value-added products, e.g., molding and floorings. New species have also been adopted successfully as shown in **Figure 3.2** – 34% increase in adoption of lesser-used species in the past five years. With the efficient creation of awareness, many companies are likely to adopt bamboo.

The best point of intervention is the strengthening of individual company organizational capabilities and core competencies. If these companies can realize their internal strengths and identify resources that are rare, valuable, and difficult to imitate and substitute, and leverage them, they can achieve sustained competitive advantage as posited by the resource-based view of the forest products firm (Bonsi, Gnyawali and Hammett, 2008). These traits will help companies to be innovative and become first-movers.

The Company's Internal Situation

The internal situations of companies are important determinants of adoption. A company that is able to identify useful resources would be more likely to engage in innovations. Such companies are able to deploy their resources and have capabilities that have been complexly formed and through unique historic conditions to achieve sustained competitive advantage (Bonsi, Gnyawali and Hammett, 2008).

As the results indicate in Chapter 4, six companies are ready to adopt bamboo in the current situation although there is not much information available. These companies may be innovators/risk takers based on the conditions that prevail in their internal environment. The reasons these companies stated for their readiness to adopt bamboo in the current situation, appear to indicate that they may be receptive to the adoption of bamboo. Some of the reasons

listed are “company is well-equipped”; “company can try”; “company uses surplus wood and so can use bamboo”; “company has knowledge about wood and may need little training to use bamboo” and; “company tried some products with bamboo”. These are all good indicators of innovativeness.

The decision made by some companies not to adopt bamboo could be contingent on the internal conditions in terms of the company’s resources. Some of these companies have adequate raw material from plantations and concessions and therefore find it unrealistic to adopt bamboo. Others do not have adequate financial and human resources to manage new ventures. The point of intervention here will be to assist companies to understand the concepts of the resource-based view and how to develop adequate desire to adopt innovations toward achieving sustained competitive advantage. Lecture series, workshops and short courses can be used by change agents to reinforce the importance of internal resources and how they can be leveraged. This will also help the Ghana forest products industry to circumvent the perceived barriers to the adoption of bamboo.

The Motivating Factors in the Company

The source of motivation for companies for adopting bamboo may be the benefits from adoption while other companies will adopt because supply of the wood raw material is dwindling. As shown in Chapter 1 **Figure 1.1**, a company was idle due to raw material shortages. Meanwhile, information about bamboo with respect to cost, products, markets and processes is limited. Hence another point of intervention is explaining how a wise deployment of internal resources can enhance desire to adopt. Sufficient information should be provided using audio visual means of communication, e.g., documentaries to describe bamboo processing, products and markets to instill desire in potential adopters. Employees should be encouraged to participate

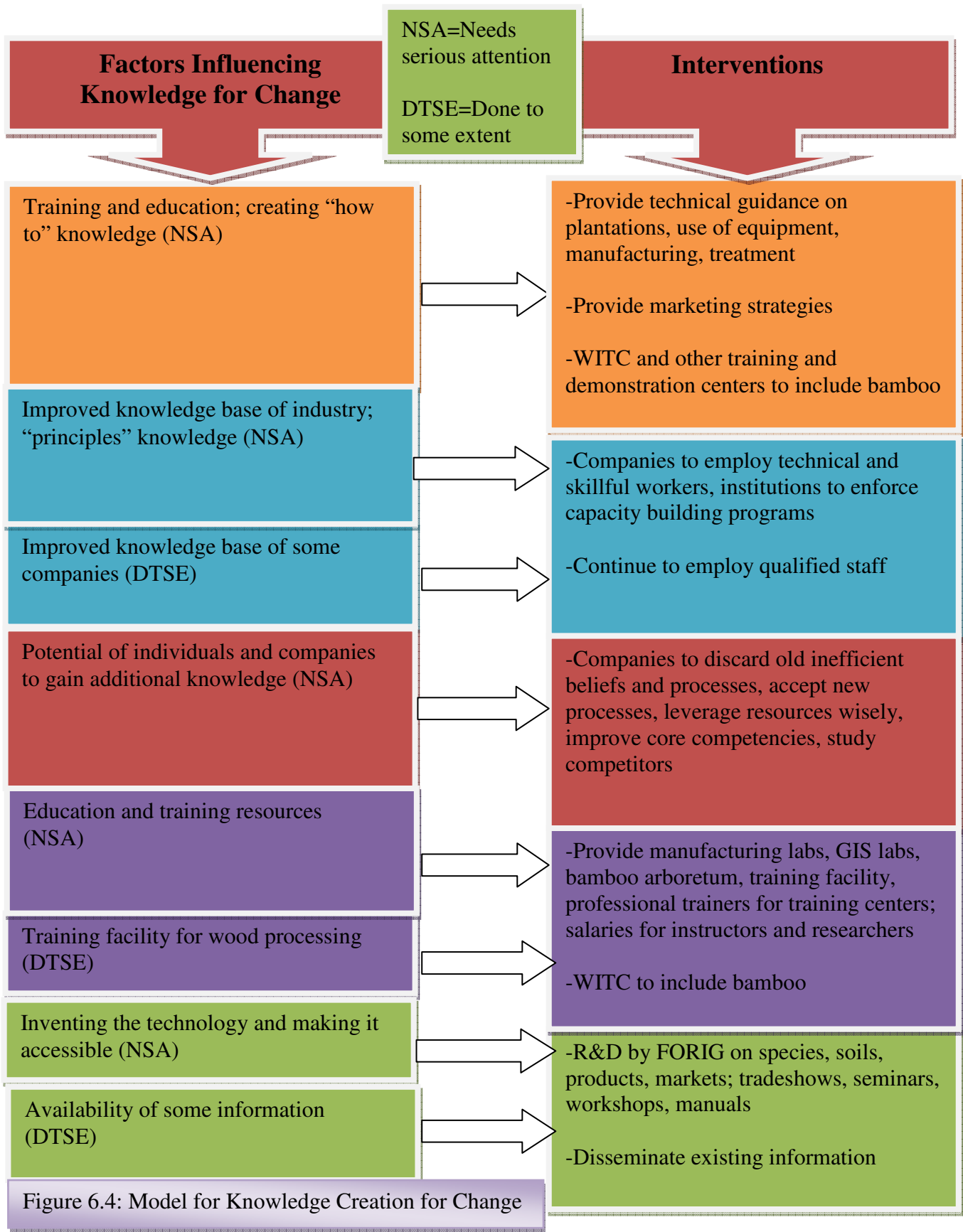
in the adoption process. They should be trained about the process and cooperative workers should be recognized and rewarded. Companies should be informed about the benefits that they will derive from converting to bamboo.

Knowledge as the Results Depict

Knowledge is prerequisite to the implementation of innovation. The importance of knowledge to companies to adopt bamboo is discussed in this section. The factors which facilitate knowledge creation help determine the points of action that would promote adoption of bamboo. The model for knowledge creation is shown in **Figure 6.4** and explained as the discussion progresses.

Training, Education and ‘How to’ Knowledge

The major needs of CEOs include adequate information, technical support and training (**Table 4.20**). The points of interventions include the provision of technical guidance and training on seed development, plantation management, and the use of equipment, manufacturing and treatment of products. Training should be given by technical training institutions such as the Wood Science Department of the Kwame Nkrumah University of Science and Technology (KNUST), the Wood Industry Training Center (WITC) and FORIG. Companies should be shown how to acquire and operate all machinery related to bamboo processing. Demonstration centers, (e.g., bamboo arboretums) should be established as learning centers. Wood educational institutions should include bamboo in their school curriculum.



The Current Knowledge Base of Companies

The current knowledge base of the adopters is important in adopting bamboo. As observed earlier, some companies have applied their current knowledge to try bamboo processing. Although there may be the need for some major changes in machines, the routine processing act is not perceived to be different. Companies have knowledge and experience with forest product processing and may apply this experience to bamboo processing. The academic achievement of the workforce is also important in building up the knowledge base of workers and companies.

The knowledge base of these companies is helpful in determining their readiness to understand the concepts of an innovation and its subsequent adoption. As **Figure 4.2** shows, there is knowledge and information gap in the industry. The industry needs qualified and technical advice personnel, processing information and product development skills. The point of action would be to assist companies to be first-movers to amass resources that set the stage for growth. Companies should employ technical and skillful workers who have technical and tacit knowledge that can be useful in inventing new things and set the basis for advancement.

Potential of Individuals and Companies to Gain Additional Knowledge

The ability of employees to learn depends on their core competencies and the qualifications of their workforce. The foundation of organizational renewal is learning that involves changes in mental models. It is clear that the potential of companies to gain additional knowledge depends on several factors such as history, the resources available to them and many other strategic factors.

The experience of workers in Ghana's forest products industry in areas such as manufacturing, saw doctoring, management, and administration is rich. This is a good standing

for knowledge accumulation. However, the managers of these companies must have astute mental models that are able to discard old inefficient ideas and processes, and replace them with new ones. They should leverage resources wisely, become innovators and study their competitors. When companies act this way, they will be able to increase their knowledge base.

The Resources Available for Education or Training

The types and quantities of resources that are available for education or training are pertinent to determining the quality of knowledge created. The results show that the resources available for education or training in the industry are insufficient. As indicated in **Figure 4.2**, firms do not have adequate financial resources for investment in processes, training, equipment and products. They also lack opportunities to acquire loans. On a five-point scale, **Figure 4.3** shows a mean value of 2.74 for the availability of capital. There are inadequate financial resources for companies to sponsor training of their workforce for the new venture. **Table 4.20** further demonstrates the intensity of lack of training or educational resources. Capital, information, technical support and training are the most pressing needs. This calls for intervention from institutions.

However, institutions lack funding, extension and research personnel, technical knowledge about bamboo, product development capability, and a major training facility that would help them assist the industry to adopt bamboo. Thus, one point of intervention would be to provide adequate training resources for both the industry and the institutions helping the industry. In addition, institutions need to be equipped with manufacturing labs, GIS labs, bamboo arboretums, and a training facility to help create the needed knowledge for the adoption of bamboo in Ghana's forest products industry. There is also the need for professional facilitators for the training centers. Instructors and researchers need to be well compensated to ensure the

successful administration of their duties. Companies have to provide training resources for their employees and sponsor selected workers to undertake short courses.

The Access to the Required Knowledge

Without access to the required knowledge of the bamboo technology, little will be known by adopters about the innovation. The needed knowledge about bamboo utilization is not adequately available. Companies were found to have little or no information e.g., on products, uses, machines, processing, cost, markets, raw material and other important information about bamboo. **Figure 4.3** indicates that existence of knowledge about bamboo is very low (i.e. 2.43 on a five-point scale). From the open-ended questions, **Table 4.19** shows that industry CEOs (65.4%) perceive lack of information or knowledge about bamboo to be a major barrier.

The second highest barrier perceived by 61.5% of respondents is lack of technological know-how about the bamboo technology. Even if the information is there, then the industry has been exposed to it only slightly. To substantiate the information in **Figure 4.3**, **Table 5.4** indicates that institutions have made little progress in diffusing information about bamboo. There are gaps between what institutions can provide now and what they may provide in the future. Since all the gaps are above 50%, much more needs to be done to create knowledge and make it accessible to the industry. The point of intervention in this case would be to conduct research in species, soils, processes, products and markets and make it accessible through documentaries, tradeshows, workshops, seminars, training, manuals, brochures and handouts.

Ability as the Results Depict

The importance of the ability of firms to adopt bamboo depends on the factors that enhance ability and the results of the study. The model for ability is shown in **Figure 6.5** and explained in the following discussion.

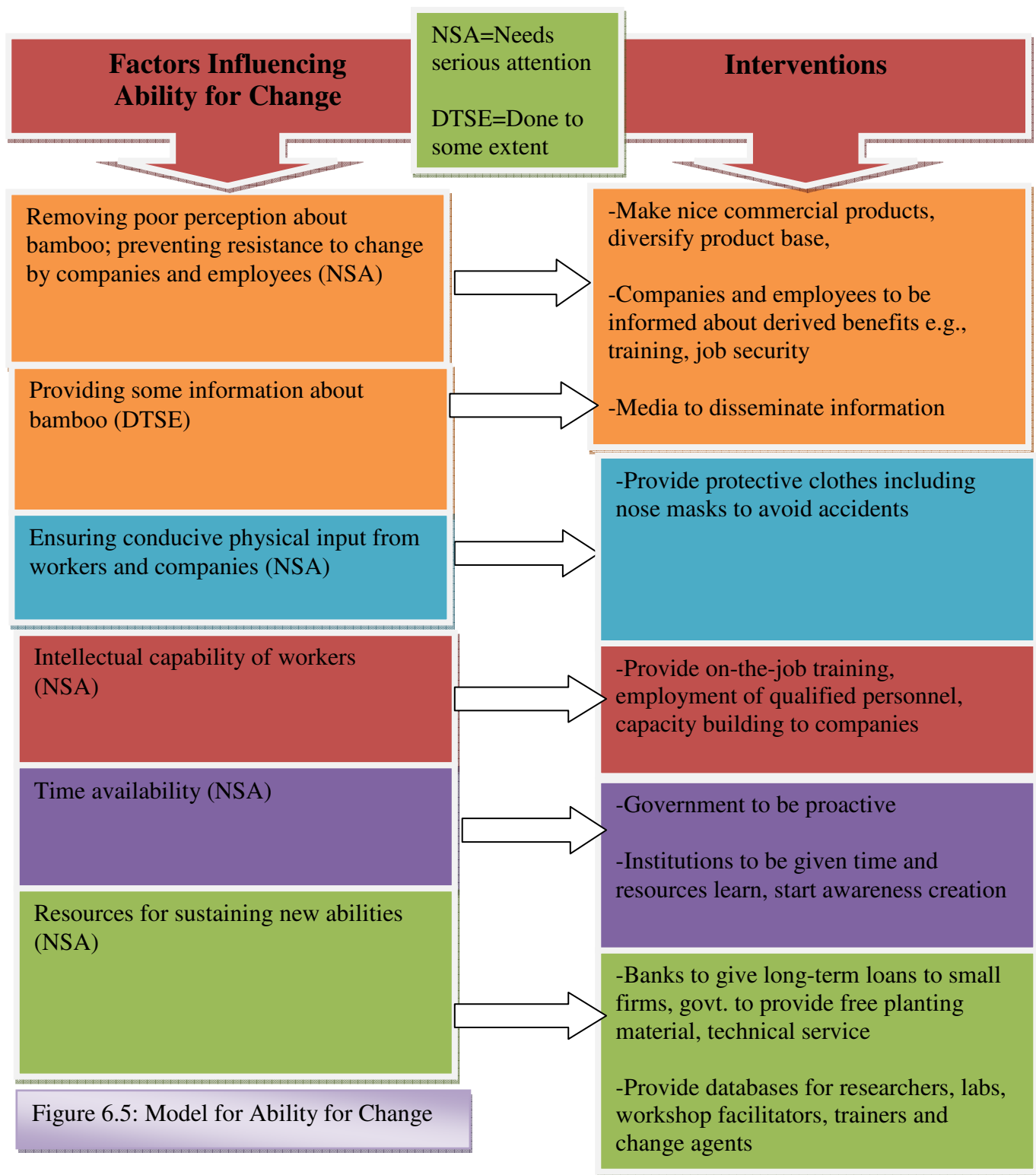
Poor Perception and Resistance to Adoption

Although some companies have good impression about bamboo, psychological barriers have been identified in the study. Both institutions and the industry perceived a slow rate in adoption because of the poor perception about bamboo. Bamboo in Ghana is considered an inferior product with little value. With this cultural inclination, it would be difficult for the society to develop interest for bamboo and bamboo products. The point of intervention would be to encourage education about the good attributes of bamboo. Nice looking commercial and diversified products should be showcased to the public and adopters.

To mitigate resistance to change, employees should be informed about the benefits they will derive if they participate or cooperate in the adoption process. Some benefits include training opportunities, self-development and job security.

Physical Requirements and Abilities

The physical abilities of the workforce of companies are important in their bid to adopt innovations. The workforce needs to be physically fit to work effectively. Adequate safety measures and medical technologies are important to ensure good health of employees. The study did not assess the physical abilities of workers but from experience, the work in Ghana's forest products industry requires physical strength but processing bamboo may be less intense.



However, handling bamboo may require more workers at a given plant. If the physical requirements are less intense, workers may be more receptive to the concept. Adoption will mean determining the intensity of physical needs and providing solutions.

Company workers need to be well trained in all the new processes such as drying bamboo and bamboo products. Workers will need to understand the chemical and physical behavior of bamboo and drying schedules. However, in Ghana's forest products industry only few workers understand the science and behavior of wood and related management processes. So the point of intervention would be to improve the intellectual capabilities of workers in the forest products industry. Employment of qualified personnel and on-the-job training are important antecedents to achieving this goal.

Availability of Time for Developing the Necessary Skills

Time is a very important element in meeting the goals of adoption of innovations. Very little has been done to introduce bamboo as a raw material on a large scale in Ghana's forest products industry. A timetable has not been set. The adoption of bamboo may need several years for the idea to come to reality. It will take time for change agents to educate the industry and concerned institutions as to what the change entails and the benefits therein. As this is a major change in the industry, ample time is needed to develop the necessary skills. The purpose, scope and schedule of the process have to be developed. However, given the current rate of deforestation, time is limited and action should be taken by the government now. Institutions need time to learn about bamboo and develop appropriate initiatives but programs to increase awareness about bamboo utilization in the industry needs to commence immediately.

Availability of Resources to Support Development of New Abilities

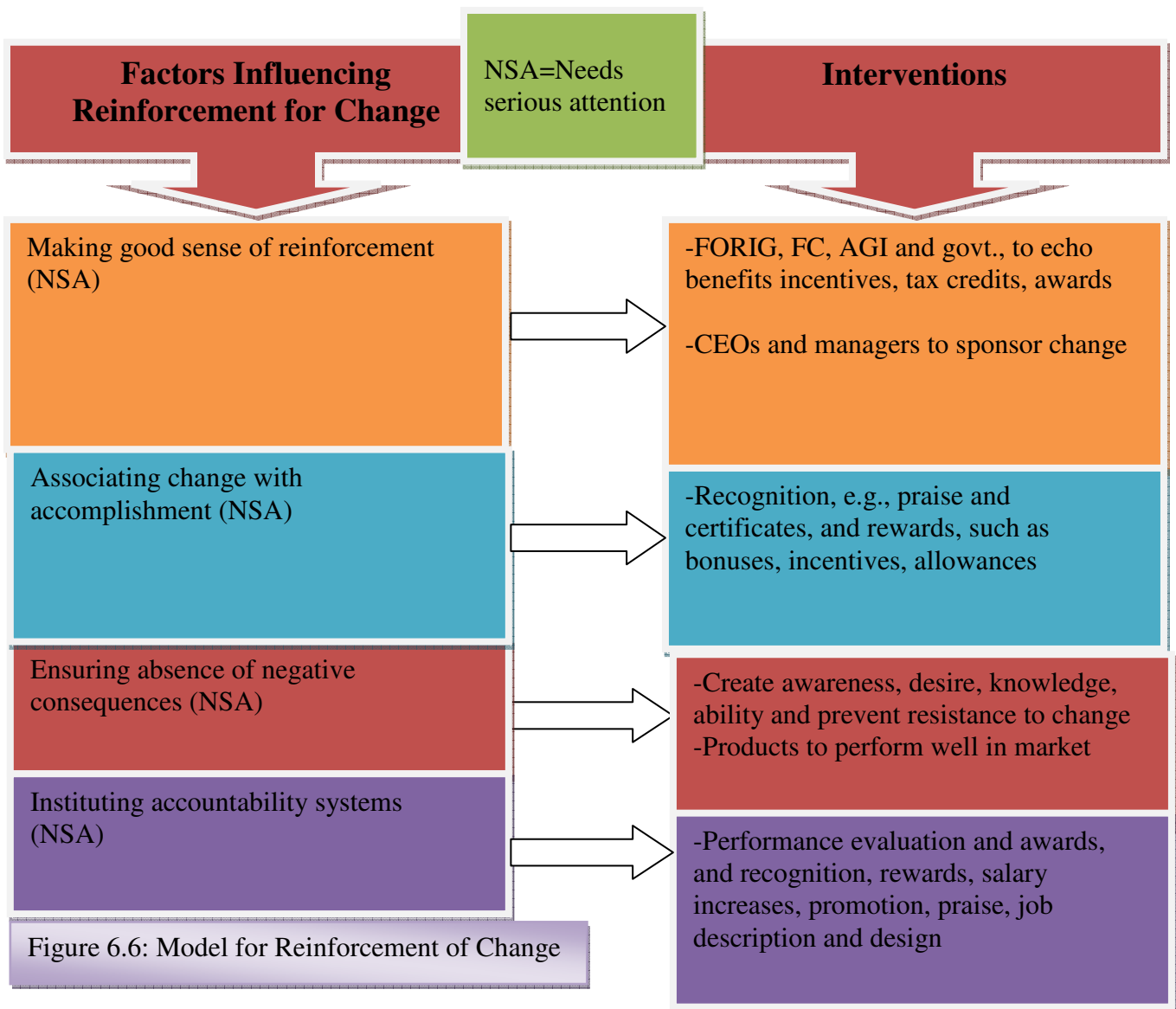
A common scenario about the adoption of innovations in Ghana is the lack of resources to sustain the innovations. As some respondents stated, government promises have encouraged farmers and other small-scale business owners to invest in economic development projects. It is sometimes discouraging to entrepreneurs who engage in such ventures but do not find markets for their products. Investors are not able to sustain their businesses due to lack of adequate resources. Financial and technical support from the government declines as time progresses and banks are reluctant to give long-term loans.

The lack of financial resources has resulted in a weak business environment. There is limited information and knowledge pool. There are limited opportunities for learning about bamboo and bamboo products. The current constraints are not favorable for developing and sustaining new abilities. Institutions have also reported limited financial and skill abilities. The best point of action would be to find ways to make more resources available. Banks and microfinance NGOs are urged to provide long-term loans to companies especially the small innovative ones and plantation owners to make necessary investments.

The government should provide incentives, (e.g., tax credits, free planting materials and free technical service) to potential adopters. Researchers need to have adequate scientific information in order to disseminate information about bamboo. Thus, they need current library databases that contain the necessary information. Labs for research and demonstrations need to be well equipped in order to serve the purpose for which they were set up. The Forestry Research Institute of Ghana (FORIG) must train new researchers who can work as qualified workshop facilitators and trainers.

Reinforcement as the Results Depict

The success of bamboo adoption will be realized when increased bamboo use is initiated. To achieve this, it is important to discuss the factors that help to facilitate longevity of change with reference to the results of this study. While important, little in the results of the study can help discuss reinforcement. However, assuming that the barriers in the industry remain the same after adoption, it would be difficult to reinforce the change. What follows is a model for reinforcement (**Figure 6.6**).



Importance of Reinforcement

It is important to distinctly state why reinforcement is important. A reinforcement that is reasonable would be welcomed by adopters. Unnecessary reinforcement would be shirked. Once bamboo has been adopted and sustained, it is expected that reinforcement ensure continued success of the program.

Based on the four elements of ADKAR that have been discussed, one can see a trend for reinforcement. The extent to which the change makes sense to adopters in this case indicates the success of reinforcement. As seen earlier, respondents are willing to adopt the innovation provided there are limited barriers. Once the change is underway, it is important to keep reminding companies and their workers about its importance and why its sustenance would benefit them and society as a whole. Reminders can be through change agents and related government institutions organizing workshops and echoing the benefits of the venture. At the firm level, reinforcement can take the form of recognition of exceptional workers. Such awards should be meaningful and valuable to recipients. Reputable institutions such as FORIG, the Forestry Commission, and the Association of Ghana Industries (AGI) should present awards to deserving companies. The CEOs, managers and supervisors of companies that have adopted bamboo should reinforce the importance of this change through reminders and interaction with workers. These points of intervention, if carried out well will help support reinforcement of the change.

Associating Change with Accomplishment and Enforcing Accountability Systems

The first and subsequent results of the change are antecedents to its reinforcement. Company workers and CEOs would remain apathetic to any change agent, supervisor or government official who attempts to undertake reinforcement amidst failed changes. Once

adopters have good impression about the change, they would be receptive to reinforcing initiatives. The point of intervention is to ensure that the initial change is successful.

Hardworking employees and innovative companies need to be recognized and praised or presented with certificates. Rewards such as bonuses and incentives, e.g., allowances can be given to cooperative employees. This will encourage award winners and indifferent workers alike to worker harder in the future.

Accountability systems such as performance evaluation of workers and companies can provide a basis for participation in the change. Hardworking employees who support the change should be motivated. Rewards can be in the form of promotion, praise and salary increases. Giving workers good job description can also instill motivation in them and make them more productive.

Conclusions

This chapter developed change management models to explain and suggest interventions that Ghana's forest products industry and related stakeholders could embrace in the process of introducing bamboo as a new raw material to supplement timber. The models were developed based on the most important needs and barriers perceived by institutions and the industry and presented in a way that would facilitate awareness creation, desire to adopt bamboo, knowledge about bamboo utilization and the ability to use the bamboo technology. Adoption of bamboo will significantly increase when these interventions are achieved. After the successful adoption, change agents need to ensure that the change is reinforced. Once reinforcement is successful, the change is considered successful.

Change agents, e.g., the government and development NGOs need to assist in awareness creation by conducting workshops, meetings, trade fairs and showing documentaries to potential adopters about how bamboo is planted, managed, harvested, processed, and marketed. This may help position bamboo better in the minds of consumers. It will also inform them about what the change entails and its enormity. In addition, public offices and government institutions such as schools, hospitals banks, and the ministries can help clear the stigma about bamboo by using bamboo products such as flooring and furniture. The implications are that the government must identify good bamboo species and provide logistics for nurseries and plantation management. The government must provide workshop equipment, i.e., computers, projectors, televisions and documentary packages to the relevant change agents.

Creating desire in potential adopters means that adopters would have to know what is in the change for them. The benefits for changing (e.g., adequate raw material, job security, training opportunities) and the risks for not changing (e.g., statistics showing decreasing trends in production and possible future closure) will have to be explained to potential adopters by change agents. The credible change agents that can effectively promote the change process include government institutions such as the Forestry Commission, banks, the Ghana Export Promotion Council, the Forestry Research Institute, and non-governmental institutions such as the International Network for Bamboo and Rattan (INBAR).

Knowledge about bamboo seed development, plantation management, processing, product development, acquisition of machines and marketing of products need to be provided. It was uncovered in the data presented in previous chapters that both the industry and institutions are faced with knowledge barriers. This implies that institutions must first clear their barriers in order to help the industry. The government is entreated to provide the necessary skills to

institutions (the change agents) to ensure success of their efforts to promote adoption of bamboo. Researchers may need some training in bamboo technology. The government should provide funding for short courses to be undertaken where bamboo technology is available. Once researchers and other change agents have received adequate training, they need to disseminate the necessary information to potential adopters at workshops, short training programs and demonstration centers.

Creating the proper awareness about bamboo will eliminate any psychological blocks and create the desire and ability to adopt bamboo. Companies which need tax breaks and lower interest rates may be assisted by the government. For example, small companies which are more innovative do not have adequate financial resources to purchase bamboo processing equipment or even establish plantations. They should be assisted by the government and development NGOs with soft loans and more flexible terms of loans. The government could formulate a policy that would make it easier for such companies to acquire long-term loans. The government could also provide assistance to companies in non-monetary ways e.g., free planting material and free technical services.

Once bamboo has been successfully adopted in Ghana's forest products industry, the change process needs to be reinforced. Adopters and workers who have pioneered and promoted the process need to be recognized and rewarded with certificates, allowances, salary increases, promotions, or simply praised in the public. Adopters need to be reminded about the change and its benefits in order to sustain it. It was observed that many of the companies, i.e., 23 out of the 26 studied are interested in adopting bamboo given limited barriers. When all the elements of the ADKAR model are well implemented, the adoption of bamboo in Ghana's forest products industry is expected to start well and the rate of adoption is expected to rise. This implies that all

the 23 companies may successfully adopt bamboo in the future. In addition, six companies are ready in the current situation to adopt bamboo, so it is suggested that the government officially start developing policies about bamboo utilization in Ghana and encourage the innovative companies to start implementing the change.

References

- Acs, Z. J. and D. B. Audretsch. 1991. Innovation and Technological Change: An Overview, In: Acs, Z. J. and D. B. Audretsch (Eds.), Innovation and Technological Change: An International Comparison. The University of Michigan Press, Ann Arbor. 208pp.
- Amit, R. and P. J. H. Schoemaker. 1993. Strategic Assets and Organizational Rent. *Strategic Management Journal* 14(1): 33-46.
- Aubert, J. E. 2001. Cultural Influences on Innovation Climate in the Industrial World, In: Sweeney, G. (Ed.) 2001. Innovation, Economic Progress and the Quality of Life. Edward Elgar Publishing Inc., UK. 182pp.
- Baldwin, R. F. 1984. Operations Management in the Forest Products Industry. Miller Freeman Publications, San Francisco. 264pp.
- Barr, P., L. Stimpert, and A. Huff. 1992. Cognitive Change, Strategic Action, and Organizational Renewal. *Strategic Management Journal*. 13(8): 15-36.
- Barney, J. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management*. 17(1): 99-120.
- Bonsi, R., D. Gnyawali and A. L. Hammett. 2008. Achieving Sustained Competitive Advantage in the Forest Products Firm: The Importance of the Resource-based View. *Journal of Forest Products Business Research*. 5(3): 1-14.
- Bontis, N., M. M. Crossan and J. Hulland. 2002. Managing an Organizational Learning System by Aligning Stocks and Flows. *Journal of Management Studies* 39(4): 437-469.
- Brinberg, D., E. Kline, D. Alderman, P. Araman, E. Cesa, S. Milauskas, T. Walthousen and J. Wiedenbeck. 2008. Exploring Research Priorities for the North American Hardwood Industry. *Forest Products Journal*. 58(3): 6-16.
- Bull, L. and I. Ferguson. 2006. Factors influencing the success of wood product innovations in Australia and New Zealand. *Journal of Forest Policy and Economics*. 8(7): 742-750.

- Cameron, E. and M. Green. 2006. *Making Sense of Change Management: A Complete Guide to the Models, Tools & Techniques of Organizational Change*. Kogan Page. London. 280pp.
- Dollinger, M.J. 2003. *Entrepreneurship: Strategies and Resources*. 3rd Ed. Pearson Education, Inc., NJ. 549pp.
- Dierickx, I. and K. Cool. 1989. Asset Stock Accumulation and Sustainability of Competitive Advantage. *Management Science*. 35(12): 1504-1511.
- Dunphy, P., A. Griffiths and S. Benn. 2003. *Organizational Change for Corporate Sustainability: A Guide for Leaders and Change Agents of the Future*. Routledge, New York. 315pp.
- Dupuy, F. 2002. *The Chemistry of Change*. Palgrave, New York. 156pp.
- Eccles, T. 1994. *Succeeding with Change: Implementing Action-driven Strategies*. McGraw-Hill, London. 273pp.
- Eliasson, G. 2001. Economic Role of Technology in a Competence Bloc Based Industrial Policy Analysis, In: Sweeney, G. (Ed.), *Innovation, Economic Progress and the Quality of Life*. Edward Elgar Publishing Inc., UK. 182pp.
- Evans, J. and C. Schaefer. 2001. *Ten Tasks of Change: Demystifying Changing Organizations*. Jossey-Bass/Pfeiffer. San Francisco. 270pp.
- Evard, B. L. and Gipple, C. A. 2001. *Managing Business Change for Dummies: A Reference for All of us*. Hungry Minds Inc., New York. 355pp.
- Feldman, M. P. and N. Massard. 2002. Location, Location, Location: Institutions and Systems in the Geography of Innovation, In: Feldman, M. P. and N. Massard (Eds.), *Institutions and Systems in the Geography of Innovation*. Kluwer Academic Publishers, London. 365pp.
- Gnyawali, D. R. and A. C. Stewart. 2003. A Contingency Perspective on Organizational Learning: Integrating Environmental Context, Organizational Learning Processes, and Types of Learning. *Management Learning* 34(1): 63-89.
- Goel, R. K. 1999. *Economic Models of Technological Change: Theory and Application*. Quorum Books, Westport, CT. 131pp.
- Grant, R. 1996. Toward a Knowledge-based Theory of the Firm. *Strategic Management Journal*. 17(Winter Issue): 109-122.
- Hansen, E., J. Seppälä, and H. Juslin. 2002. Marketing Strategies of Softwood Sawmills in Western North America. *Forest Products Journal*. 52(10): 19-25.
- Hayes, J. 2002. *The Theory and Practice of Change Management*. Palgrave, New York. 216pp.

- Henderson, R. and I. Cockburn. 1994. Measuring competence? Exploring Firm Effects in Pharmaceutical Research. *Strategic Management Journal*. 15: 63-84.
- Hiatt, J. M. 2006. ADKAR: A Model for Change in Business, Government and Our Community. Prosci Research. Loveland, CO. 146pp.
- Hill, C. W. L. and G. R. Jones. 2004. *Strategic Management: An Integrated Approach*. 6th Edition. Houghton Mifflin Company, New York. 482pp.
- Hitt, M.A., R.D. Ireland, and R.E. Hoskisson. 2007. *Strategic Management – Competitiveness and Globalization: Concepts and Cases*. 7th Edition. Thompson South-Western, USA. 428 pp.
- Holbeche, L. 2006. *Understanding Change: Theory, Implementation and Success*. Elsevier, Oxford. 455pp.
- Hultman, K. 1998. *Making Change Irresistible: Overcoming Resistance to Change in Your Organization*. Davies-Black Publishing, CA. 210pp.
- Korhonen, S. and J. S. Niemela. 2005. A Conceptual Analysis of Capabilities: Identifying and Classifying Sources of Competitive Advantage in the Wood Industry. *The Finnish Journal of Business Economics*. 54(1): 11-47.
- Korhonen, S. 2006. A Capability-based View on Organizational Renewal: Maintaining long-and short-term Potential for Growth in Large Established Companies. *Journal of Forest Products Business Research*. 3(3): 1-22.
- Kotler, P., G. Armstrong, J. Saunders, and V. Wong. 1999. *Principles of Marketing*. 2nd European Edition. Prentice Hall, Europe. 1031pp.
- Lahtinen, K. 2007. Linking Resource-based View with Business Economics of Woodworking Industry: Earlier Findings and Future Insights. *Silva Fennica*. 41(1): 149-165.
- Lane, P. J., B. R. Koka and S. Pathak. 2006. The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of Management Review* 31(4): 833-863.
- Ljungberg, S. 1982. How Can a Well Organized I&D Service Help to Improve the Innovation Process in a Company? In: B. T. Stern (Ed.), *Information and Innovation*. North-Holland Publishing Company, Amsterdam. 191pp.
- Ludolph, R. 2006. Focusing on Choice, Quality and Speed. *Des Plaines*. 78(8): 104-107.
- Mahajan, V. and R. A. Peterson. 1985. *Models for Innovation Diffusion*. Sage Publications Inc., CA. 86pp.
- McBurney, S. and J. Millen. 2008 Fueling the Need for Change. *Pulp & Paper*. 82(1): 43-47.

Peteraf, M. A. 1993. The cornerstone of competitive advantage: A resource-based view. *Strategic Management Journal*. 14(3): 179-191.

Prahalad, C. K. and G. Hamel. 1990. The Core Competence of the Corporation. *Harvard Business Review*. 68 (3): 79-91.

Rogers, E. M. 2003. *Diffusion of Innovations*. 5th Edition. Free Press, New York. 551pp.

Shields, J. L. 2006. Organization and Culture Change, In: Rouse, W. B (Ed.), *Enterprise Transformation: Understanding and Enabling Fundamental Change*. John Wiley & Sons, Inc., New Jersey. 527pp.

Streebel, P. 1998. Why do Employees Resist Change? In: *Harvard Business Review on Change*. Harvard Business School Publishing, Boston MA. 228pp.

Sweeney, G. 2001. *Innovation, Economic Progress and the Quality of Life*. Edward Elgar Publishing Inc., UK. 182pp.

Thurbin, P. 2001. *Playing the Strategy Game*. Pearson Education, New York. 220pp.

Todorova, G. and B. Durisin. 2007. Absorptive Capacity: Valuing a Re-conceptualization. *Academy of Management Review*. 32(3):774-786.

CHAPTER 7: CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

Conclusions

This study was conducted to determine the feasibility of introducing bamboo as a new raw material to supplement the traditional supplies of timber for Ghana's forest products industry. The industry has suffered from raw material shortages resulting in decreased export volumes and value. However, bamboo has been found to substitute for wood in manufacturing several products including flooring, molding and furniture. In addition, bamboo products have been found to attract competitive prices. Therefore, it is desirable to determine the feasibility of replacing some threatened timber species with bamboo to adequately supply the industry and to sustain the revenues of the forest products companies in Ghana.

Chapter 1 presented an overview of the industry, including the current resource base and production and market trends of wood products. The dwindling forest resource base is highlighted in this chapter and justifies the investigation of the use of bamboo in the forest products industry. The increased adoption of lesser-used species such as (*Afzelia africana*) (Papao) to substitute for *Milicia excelsa* (Iroko) for flooring for instance, was observed. The adoption of plantation species such as teak was also well noted. Bamboo possesses a nice yellow color appearance similar to Iroko (odum) and could easily be substituted for odum in that respect. Based on the results, bamboo could be used for relevant panel products (i.e., plywood and chipboard) and downstream products, which constitute about 22% of the industry's export output.

Chapter 2 discussed the theoretical foundations for the study. The theory of Diffusion of Innovations proposed by Rogers (2003), and the theory of Critical Natural Capital Strong

Sustainability (Tietenberg, 2000; Costanza et al., 2001; Burkett, 2006) lay the foundation for this study. The perceived attributes of innovation, i.e., relative advantage, compatibility, complexity, trialability and observability as proposed by Rogers were used to develop barrier questions for the study. These attributes in total determine how easy (based on the advantages) or difficult (based on the stringent requirements) it is to adopt an innovation. The theoretical foundations helped in arriving at some conclusions.

For example, the advantages of bamboo over wood in terms of cost as a raw material for manufacturing flooring and other forest products in addition to its low environmental impact have been identified. It was observed in the results in subsequent chapters that potential adopters may be less interested in adopting bamboo if investment requirements are not compatible with current processing requirements. Respondents also perceive adoption of bamboo to be complex, as the technology is not available. In addition, it was evident in subsequent chapters that the industry's respondents have not had the opportunity to observe bamboo processing, to try it themselves or to even learn about it. Some institutional heads have, however, traveled to China to familiarize themselves, with the concept but have not disseminated this information to the industry.

Chapter 3 determined the current situation in the industry. This was important in order to know the magnitude of the existing problems related to raw material decline and devise strategies for the adoption of bamboo to supplement timber. Therefore, the scope of the industry was determined, i.e., the quantity of raw material consumed, the size of the companies, the volume of wood product exports, product profile and markets, and the benefits companies offer to neighboring communities. Using some indicators of natural resources scarcity and experience,

the impacts of declining raw material on the industry were also determined. All these helped to understand the current situation and substantiated the next stage of the study.

The results show that many companies manufacture downstream/tertiary products such as flooring and moldings, and panel products such as plywood and particleboard, which can be produced with bamboo. It was observed that the 26 leading exporters alone consume logs about 12% more than the annual allowable cut of one million cubic meters. Adding the volumes consumed by the rest of the industry, one could clearly see that timber is harvested much more in excess of the quantity stipulated by law. However, the excess harvest does not appear to be sufficient for the industry. It was observed that there is a decline of 34% in raw material supply that has resulted in increased procurement costs by 34% in the past five years. Adoption of lesser-used species in the past five years has also increased by 36%. In addition, general operation costs have surged. The implications of the results are possible future shortages in raw material supply, closures, job losses and little help to neighboring communities. Nonetheless, given the benefits that the industry offers to communities (i.e., building of schools, hospitals and job opportunities) in addition to contributing to the country's economy, it is important to find ways of mitigating some of these impacts. Therefore, Chapter 4 of the study was designed to determine the feasibility of introducing bamboo as a supplement to the traditional timber resources in the forest products industry.

The objectives of Chapter 4 were to determine the barriers and needs perceived by managing directors/general managers and propose policy instruments for the bamboo adoption initiative. The attributes of companies that are important in adopting bamboo in the industry were also determined and helped in determining the receptiveness of the companies to the bamboo concept. Several barriers were identified that might impact the adoption of bamboo in

Ghana's forest products industry. The readiness of companies to circumvent these barriers was assumed to be a measure of their innovativeness or receptiveness to the innovation. The traits of innovativeness include their readiness to change current production lines, invest capital to acquire more land, develop their own bamboo plantations, purchase or lease new bamboo processing and harvesting equipment, and convince their customers to buy products made from bamboo instead of those made from timber.

Companies were found to be least innovative in their readiness to change their current production lines to process bamboo. This is a compatibility barrier. Processing bamboo may require a new set of machines that companies may have to purchase, an added financial burden which may deter investors. As the processing of bamboo may not be compatible with the processing of wood, the government may be required to provide processing and machine operation training to companies. The companies are also not ready to acquire more land or establish their own plantations. This behooves the government to ensure that alternative arrangements are made to ensure that adequate raw material is available to the companies by mandating community plantation management by the forestry department, as has been done for teak. Of all the required factors, companies are most ready to convince the public that bamboo is a good material. This is the least perceived barrier to the adoption of bamboo in the industry.

With respect to the variables of innovativeness (i.e., product, process and market), there was slight significant evidence that smaller companies are more ready to do product development than larger companies. Smaller companies are significantly more ready to train new managers, develop new products and treat products with preservatives. This indicates that size of company is an important attribute in the adoption of bamboo. The smaller companies, which are more receptive, need government support in loan acquisition, equipment procurement and

training. The product profile of companies does not have an influence on the adoption of bamboo, and is therefore not an important attribute in the adoption of bamboo.

Companies in the Ashanti region appear to be more ready to develop innovative products and acquire more land. Therefore, location of company is an important attribute in the adoption of bamboo. The companies under study are located in areas with varying resource endowments. For example, companies located in other regions appear to have more access to land while those in Ashanti have little access to land. Companies in Ashanti have demonstrated more readiness to do product and process innovation than companies in other regions. The government could intensify efforts to promote bamboo in the locations and company size groups where the idea appears to be more received. The innovativeness of the firms is also an attribute that is important for bamboo adoption.

The study also determined resource endowments for firms. It was discovered that companies are constrained in resource availability. The most needed resources are capital (e.g., money and machines), information about the bamboo technology (e.g., processing, products, marketing, and machines), the technological know-how about the bamboo project, and the creation of good reputation about bamboo. Both small and large companies appear to be constrained in resources to a similar degree. This implies that the government needs to pay equal attention to both categories of companies. However, smaller companies were found to be less endowed in financial resources than larger companies. From calculated scores, 25 companies out of the 26 scored above the neutral point of 3, and appear to be interested in adopting bamboo. Twenty of these companies scored between 3.8 and 4.8 on a five-point scale, indicating high receptiveness values.

In response to an open-ended question about the willingness of companies to adopt when barriers are limited, 23 of the 26 companies are ready to adopt bamboo given limited barriers. Assuming that the last three companies decide to adopt bamboo in the future, they will be regarded as the late adopters and the first 23 will be the early adopters. Once the government initiates this program and starts removing the existing barriers, a majority of the companies are expected to adopt bamboo. However, in response to an open-ended question, six companies are ready to adopt bamboo in the current situation. These six companies can be considered as early adopters or innovators and the other 20 considered as late adopters. In the situation where the three uninterested companies do not adopt at all, the late adopters would be 17.

Based on the findings of this study, several new policies would seem to be needed to help encourage the increased use of bamboo as a raw material. For bamboo adoption to be successful, the government would have to develop policies that would guide the adoption process. Some policy instruments include allocation of funds for research into bamboo species, products and markets, granting of long-term loans with favorable conditions to smaller companies especially, and training and dissemination of information, e.g., awareness creation through documentaries, workshops and seminars. The perception that bamboo is an inferior material can be changed by encouraging the use of bamboo products in government and public places such as schools, hospitals, and recreational areas. When all these new policies to encourage the use of bamboo are well implemented, bamboo could become an important alternative to wood as a raw material in the forest products industry in Ghana.

Chapter 5 focused on institutions and determined the barriers and needs perceived by institutional heads that may impact the adoption of bamboo in the industry. Several barriers to the adoption of bamboo, e.g., lack of policies on bamboo, lack of qualified personnel and

inadequate information on bamboo were identified. Needs such as research funding, technical information, training and laboratory equipment, for the successful performance of institutions and industry associations in promoting bamboo were also identified. The first step, to help promote adoption of bamboo in Ghana would be for the government to remove the barriers faced by institutions such as the Forestry Research Institute of Ghana (FORIG), the Ghana Export Promotion Council (GEPC) and the Forestry Department. In that way, the necessary inputs will have to be provided. Researchers will need labs for product development, databases for information and improved working conditions.

Gaps were identified in the capabilities of institutions in the current situation and their future capabilities to provide the necessary assistance to companies. For instance, very little has been done currently in terms of grading standards, awareness creation, research, training, and market development about bamboo compared to what these institutions hope to offer in the future. The government needs to first officially inform institutions about the concept of bamboo adoption and assign roles to each department in order to initiate the program. Some institutions, e.g., FORIG and the Timber Industry Development Division (TIDD) which is responsible for marketing can be sponsored to undertake some training in bamboo utilization and marketing in bamboo producing countries such as China and Vietnam.

Once institutions are familiar with the process and know what it entails, they can comfortably and efficiently diffuse information about bamboo to the industry. Some of the institutions that are important in providing assistance to companies are banks (for long-term finance), the Ghana Forestry Commission (for research funding, marketing, training, policy formulation), relevant educational institutions (for research and training) and the Ghana Export Promotion Council (for exports). Other important entities include the International Network for

Bamboo and Rattan (INBAR), development NGOs and industry associations. When all these entities collaborate well, the knowledge pool of the institutions may be enhanced. It is expected that these entities would diffuse the necessary information to the industry to ensure good results.

Chapter 6 of the study synthesized results from all chapters to present change management models that serve as a guideline for the industry and institutions. The chapter uses certain attributes of Hiatt's (2006) ADKAR (Awareness, Desire, Knowledge, Ability and Reinforcement) model with the results from the study to develop change management models for adoption. The results show that adoption could be successful if companies are informed (awareness creation) about the change and the risk of not changing. External change agents, e.g., FORIG, INBAR and consultants, and internal agents such as CEOs and managers, are urged to help diffuse adoption of bamboo through documentaries about the intricacies involved, workshops, presentations, seminars and face-to-face discussions. Adoption could also be successful if desire is incited in companies and workers by letting them know the benefits of changing (e.g., increased raw material supply, training opportunities and job security). The poor perception about bamboo can be reduced when reputable institutions such as FORIG and government offices, hospitals, and schools use quality bamboo products such as furniture and flooring. Change agents, such as NGOs doing industrial extension and small business development, should help disseminate knowledge (e.g., product manufacturing, performance of bamboo, marketing strategies) about bamboo technology through training, short courses, and workshops.

The ability of companies to adopt bamboo would require physical, financial and technical resources. Change agents would have to ensure that all these needs are provided to the industry. The government of Ghana should collaborate with relevant international organizations such as

the World Bank, FAO, UNDP, INBAR, CIFOR, DFID and USAID and seek financial and capacity building assistance to include bamboo utilization as one of the initiatives in Ghana to help meet the Millennium Development Goals. The rural banks, agricultural development banks and investment banks are entreated to provide long-term loans to plantation owners and small companies especially. The technical requirements of the change should be well studied and attained. When all stakeholders, i.e., the industry, institutions, industry associations and neighboring communities collaborate well and share useful information, the bamboo adoption program in Ghana could be successful. This implies that many of the companies that seem to be receptive to the idea will actually adopt bamboo as a raw material in the future. Currently, the imminent barriers will have to be removed or mitigated before companies will invest in bamboo processing.

Limitations of the Study

Although, this study focused on leading exporters, which account for about 90% of all exports, the sample sizes of 26 for companies and 32 for institutions appear to be too small to support multivariate analysis. The study covered four regions but the small sample size could not allow for regional analysis (Kent, 2001; Alreck and Settle, 2004; Hair et al., 2006) as raw material availability and other resources vary with regional location. The use of means to determine innovativeness of companies and the overall measure of the intensity of barriers may not be a distinct reflection of the real situation since a score of 1 in a particular barrier item for example, could be the only reason why a company cannot adopt bamboo. However, some results showed congruence in the cross validations that were performed, confirming the reliability of the results. In addition, since the barriers identified may be interrelated, removing some barriers, could mitigate others, and, therefore vindicate the use of means for predicting the

innovativeness/receptiveness of firms. The descriptive results shown in **Appendix E** indicate that the groups of respondents with higher mean scores actually had higher minimum scores.

Lack of adequate funding for the project constrained data collection to only leading exporters of downstream products and panel products. With a total of almost 200 companies in the country, inclusion of other downstream processors and panel product manufacturers could have given a more interesting trend of results. The interpretation of the results could also have been more reliable. However, since the companies canvassed account for 90% of the country's exports, the results could be interpreted as representative and reliable.

Future Research

Identification of barriers and needs perceived by the managing directors of the companies and institutional heads is only the first step of the efforts to introduce bamboo in Ghana's forest products industry. As was indicated in the theoretical foundation, this is an acceptability study, which determines the direction for future research. As observed in the chapters, a lot of research is needed to provide useful information to all stakeholders. Researchers need to provide information about useful species, products and how they are manufactured to avoid quality problems and suggest the markets they have to be sold into. There is the need for research data about bamboo plantation management. Cultural practices and harvesting techniques have to be established. It is important for researchers to determine the capital investment in bamboo processing. What will be the yield per volume input of raw material? How will that compare with their current wood species in terms of cost, raw material requirement and time? Which are the best soils for growing bamboo? The list for research activities is long. The Forestry Research Institute of Ghana (FORIG) is urged to collaborate with relevant institutions and their

counterparts in other countries where the use of bamboo is entrenched in order to more easily draw a research plan for the bamboo adoption project in Ghana.

References

Alreck, P. L. and R. B. Settle. 2004. *The Survey Research Handbook*. 3rd Edition. McGraw-Hill/Irwin, Inc. USA. 463pp.

Burkett, P. 2006. *Marxism and Ecological Economics: Toward a Red and Green Political Economy*. Koninklijke Brill NV, Leiden, The Netherlands. 355pp.

Costanza, R., S. Farber, B. Castaneda and M. Grasso. 2001. *Green National Accounting: Goals and Methods*, In: Cleveland, C., D. I. Stern, and R. Costanza. (Eds.), 2001. *The Economics of Nature and the Nature of Economics*. Edward Elgar Publishing, Northampton, MA, USA. 293pp.

Hiatt, J. M. 2006. *ADKAR: A Model for Change in Business, Government and Our Community*. Prosci Research, Loveland, CO. 146pp.

Hair, J. F., W. C. Black, B. J. Babin, R. E. Anderson and R. L. Tatham. 2006. *Multivariate Data Analysis*. 6th Edition. Pearson Education Inc., Upper Saddle River, NJ. 899pp.

Kent, R. 2001. *Data Construction and Data Analysis for Survey Research*. Palgrave Publishers Ltd., New York. 251pp.

Rogers, E. M. 2003. *Diffusion of Innovations*. 5th Edition. Free Press, New York. 551pp.

Tietenberg, T. 2000. *Environmental and Natural Resource Economics*. 5th Edition. Addison Wesley Longman, Inc., Reading, MA. 630pp.

APPENDICES

Appendix A: Map of Ghana Showing the Sample Frame

(The red ovals show the general concentration of mills and institutions canvassed)



Source: Ghana Homepage, 2009. Maps of Ghana: Major Cities.
<http://ghanaweb.com/GhanaHomePage/geography/> Last visited, 01/10/09

Appendix B: Recruitment Document for Respondents

Adoption of Bamboo as a New Fiber Source to Supplement Timber Supply in Ghana's Forest Products Industry: A Focus on The Principal Tertiary and Panel Product Exporters

A. L. Hammett and Richard Bonsi
Virginia Tech, USA
November 12, 2007

Recruitment Document

Thank you for your willingness to participate in this survey. The purpose of the survey is to identify barriers to the adoption of bamboo as a supplement to timber in Ghana's forest products industry. Information is being elicited from industry CEOs and institutional heads to identify barriers and help develop models towards adoption of the new material to ensure sustainable supply of raw material to the industry and slow deforestation.

Your participation is voluntary and you are free to withdraw at anytime. Your responses will not be audio-taped. They are strictly anonymous and confidential and will not be disclosed to any third party.

Thank you very much for participating!

Appendix C: Questions for Industry Managing Directors/General Managers

Interview schedule:

Adoption of Bamboo as a New Fiber Source to Supplement Timber Supply in Ghana's Forest Products Industry: A Focus on The Principal Tertiary and Panel Product Exporters

By Richard Bonsi and A. L. Hammett, Virginia Tech, USA

December 7, 2007

Date:

Start time:

End time:

Barriers to adoption

The purpose of this survey is to identify barriers to the adoption of bamboo as a supplement to timber in Ghana's forest products industry. Information is being solicited from industry CEOs and institutional heads to identify barriers and help develop models towards adoption of the new material to ensure sustainable supply of raw material to the industry and slow deforestation. Thank you for your participation!!

1. Do you know about bamboo as a raw material in the wood industry?

Yes No

2. If yes, where did you learn this from? _____

3. Do you use bamboo as raw material in your company? Yes No

If yes, where do you get it from? _____

4. Do you know any companies that use bamboo in Ghana? Yes No

5. If yes, please name them and tell me where they are located

What products are they producing? _____

6. Which of the following products have you made or think can be made from bamboo? (Tick all that apply and write 'M' against the item if the company has already made the product or 'C' if the company thinks it can use bamboo for such products).

- | | | |
|--|--------------------------------------|--|
| <input type="checkbox"/> Sliced veneer | <input type="checkbox"/> Flooring | <input type="checkbox"/> Layons |
| <input type="checkbox"/> Rotary veneer | <input type="checkbox"/> Moldings | <input type="checkbox"/> Dowels |
| <input type="checkbox"/> Plywood | <input type="checkbox"/> Broomsticks | <input type="checkbox"/> Furniture parts |
| <input type="checkbox"/> Particle board | <input type="checkbox"/> Windows | <input type="checkbox"/> Carvings |
| <input type="checkbox"/> Treated Poles | <input type="checkbox"/> Block board | <input type="checkbox"/> Doors |
| <input type="checkbox"/> Untreated poles | <input type="checkbox"/> Handicrafts | <input type="checkbox"/> Toys |

Other _____

7. Do you realize that the wood raw material base is declining?

- Yes No

8. Do you think that an alternative to wood as a raw material is necessary?

- Yes No

Please pick a number from the scale provided to show how much the following are possible or impossible for your company.

- 5 Highly possible**
- 4 Possible**
- 3 Neutral**
- 2 Impossible**
- 1 Highly impossible**

In order to use bamboo effectively

9. You may need to acquire more land _____

10. You may need to establish and manage your own plantations.._____

11. You may need to install some new processing equipment _____

12. You may need to train new managers and marketing personnel _____

13. You may need to develop new products_____
14. You may have to do more research to learn more about bamboo_____
15. You may need to buy new harvesting equipment (chain saws and more laborers)_____
16. You may need to convince your customers to buy bamboo products_____
17. You may have to look for new customers_____
18. You may need to adapt some production lines to process bamboo_____
19. You may change some production lines and equipment to process bamboo_____
20. You may incur and bear marketing cost_____
21. You may have to convince the public that bamboo is a good material_____
22. You may have to follow government policies in your operations_____
23. You may have to invest financially_____
24. You may have to treat your products with chemical preservatives_____

Needs/Barriers

How important are the following needs to you, making it easier for you to use bamboo in the future?

If you feel the item is **available in abundance**, please pick a number from the far right side of the scale. If you feel it is **extremely not available**, please pick a number from the far left. If you feel the **availability** is between these extremes, please pick a number from someplace in the middle from the scale.

Scale

Extremely Not Available 1 2 3 4 5 Available in Abundance

25. Land_____
26. Technical advice _____
27. Market information _____
28. Product development ability_____
29. Examples to show you how bamboo is being used_____
30. Opportunities for you to try the innovation_____
31. Opportunities for you to observe application of the innovation._____

32. Qualified personnel _____
33. Financial resources _____
34. Information about uses of bamboo _____
35. Information about bamboo processing _____
36. Opportunities to acquire loans _____

Cost Comparisons between Bamboo and Wood

How do you compare the following cost items between wood and bamboo? Which has a higher cost? (**Tick the one with a higher cost**)

37. Cost of land
 _____ Wood (1)
 _____ Bamboo (2)
38. Plantation mgt. cost
 _____ Wood (1)
 _____ Bamboo (2)
39. Harvesting cost
 _____ Wood (1)
 _____ Bamboo (2)
40. Hauling/transportation cost
 _____ Wood (1)
 _____ Bamboo (2)
41. Handling cost
 _____ Wood (1)
 _____ Bamboo (2)
42. Inventory cost
 _____ Wood (1)
 _____ Bamboo (2)
43. Processing cost
 _____ Wood
 _____ Bamboo
44. Marketing cost
 _____ Wood (1)
 _____ Bamboo (2)

45. Production management cost

_____Wood (1)
_____Bamboo (2)

46. Capital cost

_____Wood (1)
_____Bamboo (2)

47. Raw material cost

_____Wood (1)
_____Bamboo (2)

Open-ended Questions

48. What factors do you see as barriers to your adoption of bamboo?_____

49. What do you need (all needs) to facilitate your adoption of bamboo?_____

50. Please give any suggestions e.g. research, marketing, policies, technical advice, etc. that can help the industry and government in promoting the use of bamboo in the industry

Research:

Marketing:

Exports and imports:

Management:

Policies:

Technical advice:

Others:

51. Given your current situation, can you adopt bamboo as a raw material?

Yes No

Why?

52. Assuming there are limited barriers, would your company adopt bamboo as a raw material?

Yes No

Why?

General Questions about Company

53. Company code _____

54. Location (town, area) _____

55. Workforce (total) _____ Number of shifts _____

56. Volume of logs consumed per month _____

57. Volumes of products produced per month _____

58. Export product profile (Tick all that apply)

Air dried lumber Sliced veneer Flooring Layons

Kiln dried lumber Rotary veneer Moldings Dowels

Air dried boules Plywood Broomsticks Furniture parts

Kiln dried boules Particle board Windows Carvings

Treated Poles Block board Doors Profiled boards

Untreated poles Veneer curls Handicrafts Toys

Treated lumber

Other _____

59. To which countries do most of your exports go? _____

60. Please provide a list of services that you offer to the community _____

Current Situation in Industry

It is assumed that the dwindling forest resource base has impacted your company in the following ways in the past five years. Please state the degree to which you have been impacted (Circle one)

61. Rise in raw material cost by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%

7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

62. Drop in raw material availability by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

63. Drop in export volume by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

64. Drop in export value by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

65. Increase in difficulty in procuring the raw material by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

66. Rise in adoption of lesser-used species by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

67. Loss of customers by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

68. Drop in demand by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

69. Down-sizing by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

70. Workforce reduction by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

71. Rise in export tax payments by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

72. Drop in chances of loan acquisition by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

73. Rise in operation costs by

1. 1-5% 2. 6-10% 3. 11-15% 4. 16-20% 5. 21-25% 6. 26-30%
7. 31-35% 8. 36-40% 9. 41-45% 10. 46-50% 11. Other_____

74. What other consequences have you faced as a result of the dwindling resource base?
E.g. with customers, government, investors, employees, society, finances etc.?

Item	% Impact
------	----------

Thank you very much for your help!

Appendix D: Questions for Institutions and Industry Associations

Interview schedule for:

Adoption of Bamboo as a New Fiber Source to Supplement Timber Supply in Ghana's Forest Products Industry: A Focus on The Principal Tertiary and Panel Product Exporters

By A. L. Hammett and Richard Bonsi, Virginia Tech, USA – December 4, 2007

Organization code:

Date:

Start time:

End time:

Barriers to Adoption

The purpose of the survey is to identify barriers to the adoption of bamboo as a supplement to timber in Ghana's forest products industry. Information is being solicited from industry CEOs and institutional heads to identify barriers and help develop models towards adoption of the new material to ensure sustainable supply of raw material to the industry and slow deforestation.

Thank you for your willingness to participate!

Please *circle* the number below that shows how much you agree or disagree with the following statements. If the organization already has the item, indicate this with an 'A'. If the organization can provide the item not now, but in the future, indicate this with a 'C' on the right side of the responses.

In order for the wood industry to use bamboo effectively, your association/organization

1. Already has or can provide information on guidelines for land use and type of land to use for bamboo plantations.

Strongly Disagree		Neutral		Strongly Agree
-2	-1	0	1	2

2. Already has or can provide information on planting procedures and threshold values for fertilizers and herbicides.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

3. Already has or can provide information on type of ownership policies that should exist for bamboo plantations.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

4. Already has or can provide information on bamboo plantation management, harvesting, and hauling to the industry.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

5. Already has or can provide the bamboo species necessary for plantation establishment.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

6. Already has or can install some processing facility from which the industry may see trials and observe processing and products of bamboo.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

7. Already has or can train new technical and management staff to carry out research, develop new products, make policies and disseminate useful information on bamboo to the wood industry.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

8. Already has or can show examples of bamboo products to the industry.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

9. Already has or may have to do more research to learn more about bamboo.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

10. Already has or can convince the industry's customers to buy bamboo products.

Strongly Disagree			Neutral		Strongly Agree
	-2	-1	0	1	2

11. Already has or is ready to look for new customers for the industry
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
12. Already has or is ready to develop environmental policy instruments for the management of bamboo plantations.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
13. Already has or can provide guidelines for the utilization of the harvested bamboo
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
14. Already has or can prescribe guidelines for preservative treatment of bamboo
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
15. Already has or can provide effective marketing procedures e.g. pricing, quality, and type of products to the wood industry.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
16. Already has or can create public awareness that bamboo is a good material.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
17. Already has or can provide information as to how the industry can acquire used processing equipment.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
18. Already has or can provide information as to how the industry can acquire new processing equipment.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |
19. Already has or can provide loans to farmers to establish plantations.
- | | | | | | |
|--------------------------|-----------|-----------|----------------|----------|-----------------------|
| | -2 | -1 | 0 | 1 | 2 |
| Strongly Disagree | | | Neutral | | Strongly Agree |

	-2	-1	0	1	2
20. Already has or can provide loans to companies to acquire processing equipment.	Strongly Disagree		Neutral		Strongly Agree
	-2	-1	0	1	2
21. Already has or can provide information on grading standards of bamboo products.	Strongly Disagree		Neutral		Strongly Agree
	-2	-1	0	1	2

Needs

How important are the following needs to you, making it easier for you to influence the adoption of bamboo in the wood industry in the future?

If you feel the item is **available in abundance**, please pick a number from the far right side of the scale. If you feel it is **extremely not available**, please pick a number from the far left. If you feel the **availability** is between these extremes, please pick a number from someplace in the middle from the scale.

Scale

Extremely Not Available 1 2 3 4 5 Available in Abundance

22. Research personnel_____

23. Technical advice personnel_____

24. Market information expertise_____

25. Product development capability_____

26. Examples to show the industry how bamboo is being used_____

27. Opportunities to try the innovation yourself or help the industry to try_____

28. Opportunities for the industry to observe application of the innovation_____

29. Qualified personnel (overall)_____

30. A facility to be a major training base for the innovation_____

31. Research funding_____

32. Extension personnel _____

Open-ended Questions

33. What factors do you see as barriers that may affect your ability to influence the adoption of this innovation _____

34. What do you need (all needs) to facilitate your ability to influence the adoption of bamboo in the industry? _____

35. Please mention all the entities that are responsible for removing the barriers and providing the needs mentioned above _____

Please provide some suggestions for a better management of the following items (28-30).

36. Policies for land use, plantation management, cultural practices and ownership of plantations.

Land use:

Plantation management:

Cultural practices:

Ownership policies:

37. Policies for loan acquisitions, credit and subsidies to plantation owners and ensuring distributive justice

Policies for loan acquisitions:

Credit and subsidies for plantation owners:

Ensuring distributive justice:

38. Policies for research, extension and technical service, marketing, management, utilization of products, exports and imports.

Research:

Extension and technical service:

Marketing:

Management:

Utilization of products:

Exports and imports:

Others:

39. Through which medium do you think you can effectively communicate your knowledge to the industry?

40. Do you think your office is very important in ensuring adoption of bamboo in the wood industry? Yes No

Please give reasons:

Thank you very much for your help!

Appendix E: Some Descriptive Results

Mean Comparison of Innovativeness with Location of Company

Survey Item	Location	N	Mean	Min	Max
Company may acquire more land	Ashanti	13	4.23	4	5
	Others	13	3.23	1	4
	Total	26	3.73	1	5
Company may manage own plantation	Ashanti	13	3.92	2	5
	Others	13	3.54	1	4
	Total	26	3.73	1	5
Company may install new equipment	Ashanti	13	3.92	3	5
	Others	13	4.00	1	5
	Total	26	3.96	1	5
Company may train new managers	Ashanti	13	4.08	2	5
	Others	13	3.85	1	5
	Total	26	3.96	1	5
Company may develop new products	Ashanti	13	4.46	4	5
	Others	13	3.77	1	5
	Total	26	4.12	1	5
Company may do more research about bamboo	Ashanti	13	4.23	4	5
	Others	13	4.08	1	5
	Total	26	4.15	1	5
Company may buy new harvesting equipment	Ashanti	13	4.08	3	5
	Others	13	3.69	1	5
	Total	26	3.88	1	5
Company may convince customers to buy bamboo products	Ashanti	13	4.23	3	5
	Others	13	4.23	1	5
	Total	26	4.23	1	5
Company may look for new customers	Ashanti	13	4.46	4	5
	Others	13	3.85	1	5
	Total	26	4.15	1	5

Continued: Mean Comparison of Innovativeness with Location of Company

Survey Item	Size	N	Mean	Min	Max
Company may adapt some production lines	Ashanti	13	4.46	3	5
	Others	13	4.00	1	5
	Total	26	4.23	1	5
Company may change some production lines	Ashanti	13	3.77	2	5
	Others	13	3.54	1	5
	Total	26	3.65	1	5
Company may incur marketing cost	Ashanti	13	4.23	3	5
	Others	13	3.62	1	5
	Total	26	3.92	1	5
Company may to follow government policies	Ashanti	13	4.46	4	5
	Others	13	3.85	1	5
	Total	26	4.15	1	5
Company may invest financially	Ashanti	13	4.54	3	5
	Others	13	4.00	1	5
	Total	26	4.27	1	5
Company may treat products with preservatives	Ashanti	13	4.38	3	5
	Others	13	3.85	1	5
	Total	26	4.12	1	5

Mean Comparison of Availability of Resources – Barriers to be Removed with Size

Survey Item	Size	N	Mean	Min	Max
Availability of land	Small	14	2.86	1	5
	Large	12	3.50	1	5
	Total	26	3.15	1	5
Availability of technical advice	Small	14	2.36	1	4
	Large	12	2.75	1	4
	Total	26	2.54	1	4
Availability of market information	Small	14	2.21	1	4
	Large	12	2.42	1	4
	Total	26	2.31	1	4
Product development capability	Small	14	2.14	1	4
	Large	12	2.42	1	4
	Total	26	2.27	1	4
Examples show industry how bamboo is being used	Small	14	2.43	1	4
	Large	12	1.92	1	4
	Total	26	2.19	1	4
Opportunities for company to try the innovation	Small	14	2.21	1	4
	Large	12	2.00	1	5
	Total	26	2.12	1	5
Opportunities for company to observe application of the innovation	Small	14	2.00	1	5
	Large	12	2.58	1	5
	Total	26	2.27	1	5
Qualified personnel	Small	14	2.57	1	4
	Large	12	2.08	1	4
	Total	26	2.35	1	4
Financial resources	Small	14	2.14	1	4
	Large	12	2.58	1	4
	Total	26	2.35	1	4
Information about uses of bamboo	Small	14	2.57	1	4
	Large	12	2.58	1	4
	Total	26	2.58	1	4
Information about bamboo processing	Small	14	2.29	1	4
	Large	12	2.33	1	4
	Total	26	2.31	1	4
Opportunities to acquire loans	Small	14	2.36	1	4
	Large	12	3.17	1	5
	Total	26	2.73	1	5