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Towards Bamboo Commercialization in Ethiopia

Analysis of Technology Sources, Innovation and Entrepreneurship

A dissertation submitted in fulfillment for the requirements of the degree **Doctor rerum silvaticarum (Dr. rer. silv.)**

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Declaration of Conformity

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List of Abbreviations

AAU	Addis Ababa University
ADLI	Agriculture development led industrialization
ASI	Agricultural System of Innovation
asl	Above Sea Level
CFC	Common Fund for Commodity
°C	Degree Celsius
CSA	Central statistical agency
CEE	Center of Excellence in Engineering
E.G.	For Example
et al.	And others
ETB	Ethiopian Birr
etc	And so on
E	East
FAO	Food and Agricultural Organization
FDI	Foreign Direct Investment
FeMSEDA	The Federal Micro and Small Enterprises Development Agency
GDP	Gross Domestic Product
GIZ	German Federal Enterprise for International Cooperation
GO	Government Organizations
GTP	Growth and transformation plan
IKEA	Ingvar Kamprad Elmtaryd Agunnaryd (Swedish furniture retailer)
INBAR	International Network for Bamboo and Rattan
KM	Kilo meter
m	Meter
mm	Millimeter
MNE	Multi National Enterprises
MoARD	Ministry of Agriculture and Rural Development of Ethiopia
MOEF	Ministry of Environment and Forests
MoFED	Ministry of Finance and Economic Development
MOE	Ministry of Education
MOI	Ministry of Industry
MOST	Ministry of Science and Technology
MUDC	Ministry of Urban Development and Construction
N	North
NGO	Non-governmental organization
NIS	National system of Innovation
NTFP	Non-timber Forest Products
ODF	Official Development Assistant
OECD	Organization for Economic Cooperation and Development

R&D	Research and Development
RRA	Rapid Rural appraisal
SI	Systems of Innovation
SNNPRS	Southern Nations, Nationalities and Peoples regional state
SPSS	Statistical Package for Social Science
SSI	Sectoral System of Innovations
SWOT	Strength, Weakness, opportunity and challenge
TT	Technology Transfer
TVET	Technical and Vocational Education and Training
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD/ US$	United States Dollar
WGC	Wondo Genet College

Abstract

The purpose of this thesis is to explore factors, actors and processes which condition innovative commercialization of bamboo in Ethiopia. The thesis particularly focuses on how traditional technologies and entrepreneurial innovations can be a source of knowledge and foundation for bamboo commercialization in Ethiopia. In tandem with technology development, it also attempts to shed light on how variations in value chains and market availability result in differential levels of commercialization. The research is designed based on the system of innovation and value chain approaches as main theoretical lenses. Data is collected from three districts and cities. The main data collection method was surveys of key value chain actors, complemented by expert interviews, case studies, group discussions and analysis of secondary data sources. Both qualitative and quantitative techniques including inferential statistics are used for analysis. The results demonstrate that traditional knowledge and technical skills are key sources of innovation for bamboo commercialization. These technical skills are gradually transferred from rural to urban and from traditional to semi-modern via recreational houses and furniture production. The research found that the major factors which significantly explain the differences in technical skills are bamboo income, use knowledge, market distance and management regimes. The study further reveals that there are diversity of enterprises which have a major role both in generation of innovation and production of value added products. Innovation performance is influenced by level of technology, financial access and business experience while economic performance is influenced by the age of the enterprise owner, their innovativeness, level of technology and location (urban functions). Institutional actors play an intermediary role at the production and processing levels in promoting bamboo sector development through training provision, policy development and linking actors along the value chain. Similarly, consumers are also key actors in the value chain and are the major drivers of bamboo commercialization. Rates of commercialization are found different among regions where areas with a better access to consumer markets reportedly engage more in commercial extraction and earn a correspondingly higher income from bamboo than regions far from centers of consumption. In summary, the empirical analysis depicts that innovative commercialization is the result of a combination of technological capability, entrepreneurial competency and market accessibility. Thus, future policy for bamboo resource commercialization and development should be geared towards establishing and nurturing a bamboo sector innovation system which in turn supports the development of technology-led resource commercialization and facilitates entry into the global value chain.

Zusammenfassung

Diese Dissertation hat zum Ziel, Faktoren, Akteure und Prozesse zu erforschen, welche die innovative Kommerzialisierung von Bambus in Äthiopien bedingen. Insbesondere wird in dieser Arbeit darauf eingegangen, inwiefern traditionelle Technologien und unternehmerische Innovationen eine Wissensquelle und ein Fundament für die Bambuskommerzialisierung in Äthiopien sein können. Zusammen mit der Technologieentwicklung wird auch dargestellt, wie Variationen in der Wertekette und der Marktverfügbarkeit zu unterschiedlichen Graden der Kommerzialisierung führen. Die Forschung basiert auf dem System von Innovations- und Wertekettenverfahren als grundlegende theoretische Aspekte. Die Datenerhebung erfolgte in drei Distrikten und Städten. Die Haupterfassungsmethode war die Befragung von Schlüsselakteuren in den Werteketten, ergänzt durch Experteninterviews, Fallstudien, Gruppendiskussionen sowie Analysen von sekundären Datenquellen. Sowohl qualitative als auch quantitative Verfahren einschließlich der Interferenzstatistik dienen der Analyse. Die Ergebnisse zeigen, dass traditionelles Wissen und technische Fertigkeiten Schlüsselquellen für Innovationen in der Bambuskommerzialisierung sind. Diese technischen Fertigkeiten werden nach und nach vom Ländlichen zum Städtischen sowie vom Traditionellen zur Semimoderne überführt, was sich hauptsächlich durch den Erholungssektor sowie durch die Möbelherstellung zeigt. Die Forschung fand heraus, dass die Hauptfaktoren der Unterschiede in den technischen Fertigkeiten das durch Bambus erzielte Einkommen, das Wissen über dessen Verwendung, die Distanz zum Markt sowie Managementregime sind. Ferner zeigten die Untersuchungen, dass es eine Vielfalt von Betrieben gibt, welche eine Hauptrolle sowohl bei Innovationen als auch bei der Herstellung höherwertiger Produkte spielen. Die Innovationsleistung wird beeinflusst durch den Stand der Technik, durch finanziellen Zugang sowie Businesserfahrungen, während die ökonomische Leistung beeinflusst wird durch das Alter der Betriebsbesitzer, deren Innovation, den Stand der Technik, sowie durch die Lage (urbane Funktionen). Institutionelle Akteure spielen eine Zwischenrolle auf Produktions- und Verarbeitungsebene bei der Förderung der Entwicklung des Bambussektors durch Bereitstellung von Ausbildung, der Entwicklung von Methoden und verbindenden Akteuren entlang der Wertekette. Ähnlich sind auch die Konsumenten Schlüsselfaktoren in der

Wertekette sowie Hauptantrieb für die Bambuskommerzialisierung. Die Kommerzialisierungsraten in den einzelnen Regionen sind unterschiedlich, wobei Gebiete mit besserem Marktzugang eine größere Kommerzialisierung bewirken und ein besseres Bambus-basiertes Einkommen erzeugen als Regionen, die sich fernab von den Zentren der Konsumption befinden. Zusammenfassend kann ausgeführt werden, dass die empirische Analyse zu dem Schluss kommt, dass innovative Kommerzialisierung das Ergebnis einer Kombination technischer Fähigkeit, unternehmerischer Kompetenz sowie der Marktzugänglichkeit ist. Folglich ist die zukunftsorientierte bambusbasierte Kommerzialisierung und Entwicklung so zu lenken, dass das Innovationssystem auf dem Bambussektor etabliert und gestärkt wird, wodurch auch die Entwicklung technologiegeführter Ressourcenkommerzialisierung gefördert sowie der Zugang zur globalen Wertekette begünstigt wird.

1 Introduction

1.1 Background

Non-timber forest products (NTFPs) have been important resources for traditional societies. However, the role of NTFPs had been diminished for a long time until it was revived with the environmental movement of the 1980s. After this period however the use of NTFPs for economically and environmentally sustainable development has received increasing attention among academics, politicians and practitioners (Ros-tonen and Wiersum 2005; Sheona et al. 2011; Wunder et al. 2014). The premise behind the assumption and the renewed interest was that the inclusion of NTFPs in forestry accounting increases the value of the forest and hence becomes an incentive for forest conservation (Belcher et al. 2005). In order to further enhance its presumed contribution and significance, particularly in relation to competing land uses, adding values and increasing income from NTFPs is essential. To this end, innovation at the production and processing stage of non-timber forest products as well as integrating them with local and global markets have been on the agenda among states and development partners working in the forestry sector. In spite of this most developing countries, especially those in Africa, are still trading primarily unprocessed products and are locked in low-skill activities (Lall and Pietrobelli 2002; World Bank 2006; Juma 2011; Bell 2007) while little progress has been registered for manufactured products (Juma 2011; Bell 2007).

Poor performance in productivity and international competitiveness is often justified on general policy and governance failures and largely disregards the impact of technological constraints (Lall and Pietrobelli 2002). While policies and governance failures are still major factors, the failures are equally attributed to limited technological facilities and technological and entrepreneurial knowledge (Held 2004; Ferranti 2003; Porter 1990; Lall and Pietrobelli 2002; World Bank 2006; Lee et al. 2014). Hence, technological and organizational innovation for products which have clear market potential is one of the key perquisites for knowledge-based development (Pretzsch et al. 2014).

Knowledge and technologies essential for NTFP development could be generated and advanced by actors in the value chains, primarily by value adding enterprises. Many of these enterprises in developing countries are small-sized, informal and survivalist. They have limited options to gain knowledge for innovation. As a result, they are generally non-innovative enterprises (Altenburg and Meyer-Stamer 1999) and engaged in the production of traditional products with manual technologies to fulfill daily subsistence

(UNCTAD 2007). However, depending on their market orientation and learning (Keskin 2006; Pérez-Luño et al. 2010), there could exist growth oriented enterprises many of which have the propensity to innovate if assisted by enabling business environment and supportive institutions (Hunt 2012). They could be key players in development of product innovations, transfer of technologies and increasing the marketability of newly developed or improved products. However, in many developing countries, even the growth firms have still limited capacity to produce internationally competitive manufacturing products and enter in global competitive value chains (Lee et al. 2014). As a result, most developing countries depend on the export of a few commercialized, technology-extensive natural products (UNCTAD 2007). Attempts to commercialize a broader range of potential resources through value addition are still meager. Consequently, most of the resources remain underutilized or low value subsistence products. Even those products with ample potential for commercialization are constrained by these challenges.

Commercialization can be defined as the integration of a product in a market economy which may be expressed by an increased trade value (Marshall et al. 2006; Leavy 2008; Pingali and Rosegrant 1995; Ingram 2014) or by the proportion of sale to the total income (Govereh et al. 1999; Nepal and Thapa 2009). From a product innovation perspective, commercialization can be defined as the development and market implementation of new or existing products (Roozenburg and Eekels 1995; van Lugt and Otten 2006). For many agricultural products, commercialization may not necessarily require technological innovation[1]. However, bamboo, especially in its industrial form, requires substantial processing and a modest level of manufacturing technology to realize quality product development and enter into a competitive market. Thus, it is argued in this thesis that development of technological, product and organizational (entrepreneurial) innovation are crucial to stimulate value-added commercialization of bamboo in Ethiopia.

Innovation has several definitions and typologies (Popadiuk and Choo 2006). However, the broader and most comprehensive definition encompasses the introduction of a product or a significant improvement in the quality of an existing product; the introduction of a new method of production; the opening of a new market; the opening or development of a new source of supply of raw materials and the creation of a new type of firm organization (OECD 2005). Innovation is a source of sustainable development and one of the building blocks of sustainable competitive advantage for a nation or an enterprise (van Horne et al.

[1] See page 12 for definitions

2006; Porter (1985). Baldwin and Hanel (2003) argue that innovation is the dynamic force that changes the economy and is at the heart of entrepreneurship. Kaplinsky (2000) mentions innovation in product and organization as the greatest source of rent in a value chain. However, innovation is resulted from a complex process and interaction of technological capability, innovation friendly governance and deeper social and cultural factors (Fagerberg and Srholec 2008; Fagerberg and Shrolec 2009; Altenburg 2009). To address these issues, recent studies have shifted from the linear model to a more systemic and interactive learning approach to analyze innovations (Lundvall 2010; Edquist 2013).

It is argued that the bamboo sector of Ethiopia has not only underdeveloped processing technology but also underdeveloped market and innovation institutions. In this situation, enterprises might have low entrepreneurial experience and capital endowment which in turn may limit the range of entrepreneurial operation (UNCTAD 2007). On the other hand, abundant resource availability, rapid growth features, good mechanical properties and excellent environmental service functions mean that the species has great potential for commercialization. Given this context, understanding of the options and processes for innovative production and commercialization of the bamboo resource remains an important research agenda.

1.2 Global Outlook of Bamboo Resources and Commercialization

With over 1500 documented uses (Bystriakova et al. 2004), bamboo is one of the most valuable and important non-timber forest products (Lobovikov et al. 2007; d'Oliveira et al. 2013). An estimated 2 billion people depend on it for their daily subsistence (INBAR 1999; Pathak et al. 2014). Moreover, about 2 million artisans in India and more than 1000 large bamboo manufacturing firms who buy from millions of bamboo farmers in China are bamboo dependents (Zehui et al. 2012; Held 2004).

Its image is improving from poor-mans-timber to a global commodity (Lobovikov et al. 2007) with a global market value of nearly US$10 Billion (INBAR 2014). Owing to its growing recognition and improved image, its value has been growing steadily (Pathak et al. 2014). For instance, in China, the national production value of bamboo industry increased from US $13.1 Billion in 2010 to US$ 19.5billion in 2012 while the Indian bamboo industry expected to reach US$ 4.4 billion in 2015, which is a substantial improvement from US$ 35million in 2003 (INBAR 2014; Baksy 2013). The export value of higher technology value-added bamboo products (such as engineered bamboo panels, bamboo furniture, etc.) increased faster than the traditional ones (such as, bamboo mats and basketworks (INBAR 2014). Of the total global market (US$ 1.9 Billion), 29% was industrialized bamboo products out of which 25% was bamboo woven products (INBAR

2014). The same report shows that European Union, United States and Japan are the top three importers of bamboo and rattan products in the world where they collectively accounted for 72% of the world total imports in 2012. While the leading producing and exporting countries are China, Vietnam, Philippines, Singapore, Thailand, Indonesia, Malaysia and Myanmar.

While Asian countries such as India, Thailand, Vietnam, Malaysia, Indonesia are performing well in bamboo technology development and trade performance, no other country in the region and in the world has developed the potential of their bamboo resources to such an extent as that of China (Hogarth and Belcher 2013; Mera and Xu 2014; Pathak et al. 2014; van Lugt and Otten 2006). China has the largest bamboo resource, highest consumption and largest and fastest growing industry (Bowyer et al. 2014; Buckingham et al. 2011; Yiping and Henley 2010; Hogarth and Belcher 2013; Marsh and Smith 2007; Mera and Xu 2014). It is the largest exporter of both traditional and high technology bamboo products (INBAR 2014) with a global market share of over 70% (Hogarth and Belcher 2013). China has also the largest manpower in bamboo research and development. A total of 450 bamboo products and patented technologies enjoy intellectual property rights, as well as over 500 practical techniques on bamboo utilization developed (Xuhe 2003; Zehui et al. 2012). China's dominance is also attributed to a long cultural tradition of bamboo and bamboo use (Naixun and Zhaohua 2001; Held 2004) and a series of enabling policy reforms in the mid-1980s that impacted land tenure and forest use rights, markets, and commercialization (Hogarth and Belcher 2013; Held 2004; Hogarth 2013; Zhaohua 2008).

As a result, countries planning to commercialize their bamboo resource often focus on China as a model. As explained above, though China can be a source of technology and inspiration to develop bamboo resources of other nations, it could also put major entry barriers to global industrial bamboo product trade. According to previous studies from Latin America (Takahashi 2006) and from South East Asia (Smith and Mestre 2009), it was found difficult to compete with established Chinese firms. Thus, the presence of the technology to be copied could be seen as a global asset for bamboo commercialization, while China’s excessive domination of the global bamboo production and trade could be a liability for newcomers in the bamboo business.

1.3 Bamboo Resources and Commercialization in Africa

Bamboo is found naturally distributed in large areas of Africa with over 40 species covering more than 3 million hectares. Most of the African bamboo resource is found in natural forest forms. It has been largely used for small crafts, house construction and other utilities. While there is no comprehensive empirical

study on how bamboo is valued across Africa, several case studies in the continent have shown that it is less valued than wood products (Obiri and Oteng-Amoako 2007; Endalamaw et al. 2013; Ingram and Tieguhong 2013b).

Moreover, the level of technology for bamboo utilization in all African countries remains largely traditional and only a few manufacturing firms are reported (Athanasiades et al. 2009; Ebanyenle et al; Ingram and Tieguhong 2013b). Recently, increased attention is given to the sector especially within INBAR member countries. A number of studies are published from Nigeria, Ghana, Kenya and Cameroon, mainly in socioeconomics, material utilization, development and policy issues (e.g., Minae 1989; Kigomo 1995; Onilude 2005; Embaye; Ogunwusi 2013; Onuorah et al. 2014). There have been also base line surveys by INBAR about the production - consumption systems of bamboo in several African countries (Chihongo et al; Esegu et al. 2000). Yet, they are still limited in scope and are not adequate to bring about bamboo commercialization in the region. Thus, although the resource is native in this region, Africans bamboo utilization, product awareness and market integration is far lower than Asian countries (Ingram and Tieguhong 2013a). Consequently, technology transfer from Asia to African is considered as a possible option for technological catch up and market competitiveness.

1.4 Bamboo Resources and Commercialization in Ethiopia

The bamboo resource of Ethiopia is estimated at 1 million ha (FAO 2005; Mengesha 2011). However, this figure is questioned as there is acute deforestation in most of the natural bamboo forest areas caused by expansion of small scale and large scale farms, human settlements and forest fires (FAO 2005). The majority of the Ethiopian bamboo resource is distributed in natural forest or woodland occupying different parts of the natural landscape. There are also managed bamboos plantations. Like any land resources in Ethiopia, bamboo forest lands are de jure state owned while bamboo plantations are under de facto farmers' ownership.

There are two species of bamboo: the lowland bamboo (*Oxytentra abyssinica*) and the highland bamboo (*Yushania alpina*). They are native species to Ethiopia (Embaye 2003). The lowland bamboo is sympodial (clumped) type while the highland bamboo is monopodial (spreading) types. The lowland bamboo is distributed mainly in southwestern lowlands of Ethiopia, while the highland bamboo covers large areas of the country both in the southeastern highlands and the western parts of the northwestern mountain massifs. Ecologically, the highland bamboo grows at high altitude 2000-4000 m above sea level (a.s.l) and

in a relatively cool average annual temperature of 14–17°C (PROTA 1989). Lowland bamboo thrives in dryland parts of the country with relatively low annual rainfall and a higher temperature.

The highland bamboo resource is relatively small in area coverage. However, it is preferred by craftsmen and is better utilized compared to the lowland bamboo. Studies on its wood properties (density, fiber length, cell wall thickness, wettability and buffering capacity) proved that the species fulfills the ISO standards for industrial products such as ply board, laminated bamboo lumber (LBL), oriented strand board (OSB), medium density fiber board (MDF) and floor boards (FRIM, 2008). Moreover, studies show that a number of industrial bamboo products including pulp and paper, charcoal, furniture, and edible shoots can be produced from highland and lowland bamboos (Kelemework et al. 2008). The highland bamboo is growing relatively fast and with a six year rotation cycle and 20% removal of stems, it can yield 10 ton/ha/year (Mengesha 2011).

Despite its industrial potential (Boeck 2014), it is used for low quality products and provides low economic return for farmers and other actors (Embaye 2003; Endalamaw et al. 2013). Most bamboo processing enterprises and farmer consumers use manual technology and produce less durable products (Endalamaw and Pretzsch 2012). Similarly, markets for bamboo are not well developed (Kelbessa et al. 2000; Andargachew 2008; Endalamaw et al. 2013; Mekonnen et al. 2014). The majority of production is used for subsistence while only a third of the estimated production is destined for the market (Endalamaw et al. 2013). Market linkages are weak with a small number of intermediaries and trade is largely restricted to local and national markets (Endalamaw et al. 2013).

1.5 Research Problem

Bamboo commercialization attempts are underway in Ethiopia under the frame of south-south cooperation with the assistance of the Chinese experts under the auspices of International Network for Bamboo and Rattan (INBAR). The general approach is the transfer of technology from Asian countries to gradually build local technological capability in Ethiopia. For this purpose, three Bamboo production districts: Sidama (in the south), Beneshangul (in the western) and Awi (in north eastern) part of the country have been selected as pilot learning sites for improving bamboo production and processing technology. Moreover, government delegates have traveled to China several times for experience sharing and to discuss options of technology transfer. This may be an indication that the government has also shown interest for bamboo based technology development and resource commercialization.

However, this government interest for bamboo development in Ethiopia is not the first of its kind. A similar interest was shown in the 1980's. In both cases, the process has been government-led and started with the aim of transferring Chinese technologies and success experiences to Ethiopia. However, the bamboo commercialization effort in Ethiopia has not shown any major stride so far. Although technology transfer is an option, its success is largely dependent on indigenous technology and human capability as well as conducive institutions and organizations for identification and absorption of foreign technologies (Fu et al. 2011; Altenburg 2009; World Bank 2008; Bell 2007; Ferranti 2003; Marcelle 2004). Moreover, although bamboo development experience of China has aspects of technology transfer, most of the achievements registered are the result of endogenous efforts in technology development, dissemination and product development and market integration (Zhaohua 2008). Furthermore, Douthwaite (2002) argues that several promising technology transfers fail due to inappropriate technology (source) selection, matching with existing systems, ill-suited communication methods and too much haste in the adoption process. Thus, to upgrade the production system and successfully commercialize bamboo, there is a need to decide on the technology sources including availability and extent of indigenous technology and their potential as a basis for endogenous technology development. This type of knowledge is lacking and previous attempts were not based on a sound knowledge base. Thus, there is a need to systematically understand the extent of existing traditional bamboo knowledge, technology and utilization culture.

Although indigenous knowledge may be one of the sources of technology and pathways for bamboo development in Ethiopia, there is a need to improve it with continuous innovation in products and technologies to enter and compete in the global value chain. Innovation is a complex process and is affected by a diversity of factors. To describe this diversity of causal factors, Bamberry (2010) uses the term "cumulative causation". The major factors are nature of innovation, technology source, interactive learning, innovation organization and institutional conditions (Dosi 1982; Edquist and Johnson 1997; Lundvall 2010; Landry et al. 2002; Marcelle 2004; Altenburg et al. 2008; Soete et al. 2010; Douthwaite et al. 2001; Borras and Edquist 2014). There are also arguments that innovation takes place mainly in large and knowledge intensive industries rather than low technology industries (Nooteboom 1994; Slee 2011). However, counter arguments show that innovations can also be produced by low level cottage industries and craft makers (Voeten and Naudé 2014; Voeten et al. 2011; Robson et al. 2009; Gebreeyesus 2009). Thus, understanding the innovation processes, determinants and constraints is also crucial for Ethiopia, as these issues were not systematically investigated for the bamboo sector so far.

In innovation and development studies, technology and market perspectives are important components and are dealt with side by side (Abernathy and Clark 1985; Henderson and Clark 1990; Chandy and Tellis 1998). Similarly, in the bamboo sector of Ethiopia, there are several actors from bamboo resource production to consumption who are mainly networked and governed by market forces (Endalamaw et al. 2013). In this relationship, there exist the entrepreneurial actors, with a major role in processing raw bamboo into secondary products. There are also the institutional actors[2] which may facilitate or hinder the performance and activities of enterprises and other actors. The motivation for innovation and commercialization of bamboo may be dependent on the demand for bamboo products among existing and potential consumers. The role of these various actors in the development of bamboo innovation and commercialization is little understood.

Thus, this research attempts to fill these gaps by investigating the role of indigenous and transferred technologies, enterprises and institutional actors in determining bamboo innovation and commercialization options in Ethiopia

1.6 Research Objectives and Questions

The general objective of this thesis is to understand bamboo production and processing technologies and determine factors and actors contributing to or deterring innovative commercialization of bamboo in Ethiopia.

Specific objectives

- Investigate traditional knowledge and utilization technologies and their role for innovative commercialization.
- Describe the characteristics, performance and innovation propensity of bamboo entrepreneurs and empirically determine factors affecting their innovativeness.
- Examine the determinants of bamboo value chain development and commercialization.
- Analyze and synthesize systemic options for innovative commercialization of bamboo in Ethiopia.

In order to address the research objectives, the following operational research questions are set.

[2] Institutional actors are institutions, government agencies and non-governmental organizations working on bamboo innovation and commercialization in the different stages of the value chain.

1. What type of bamboo-based traditional knowledge and technology is available in Ethiopia? Which socioeconomic factors explain knowledgeability and skillfulness?
2. How do bamboo processing enterprises characterized and which factors condition their performance?
3. Which factors determine entrepreneurial innovation and how do institutional actors support innovation processes?
4. What are the determinants of commercialization in bamboo production to consumption systems and how do actors interact along the value chain?
5. How does innovative commercialization of bamboo be nurtured in Ethiopia?

1.7 Thesis Outline

The subsequent chapters are organized as follows. Chapter two sets the theoretical bases and conceptual framework. Chapter three presents the study settings and the method for data collection and analysis. In Chapter four, the traditional knowledge about bamboo and the diversity of utilization technologies are reported. The thesis moves to the processing stages by dealing with the bamboo enterprises and their characteristics in chapter five. Chapter six discusses innovation attempts and performances by different sized bamboo enterprises and supporting institutional actors. Chapter seven deals with the bamboo value chain and determinants of bamboo commercialization. Chapter eight brings all the theoretical and empirical results together and systematically discusses the options and challenges of innovation and commercialization in Ethiopia. In the same chapter, the thesis concludes by presenting a summary of major findings and limitations of the study (Figure 1.1).

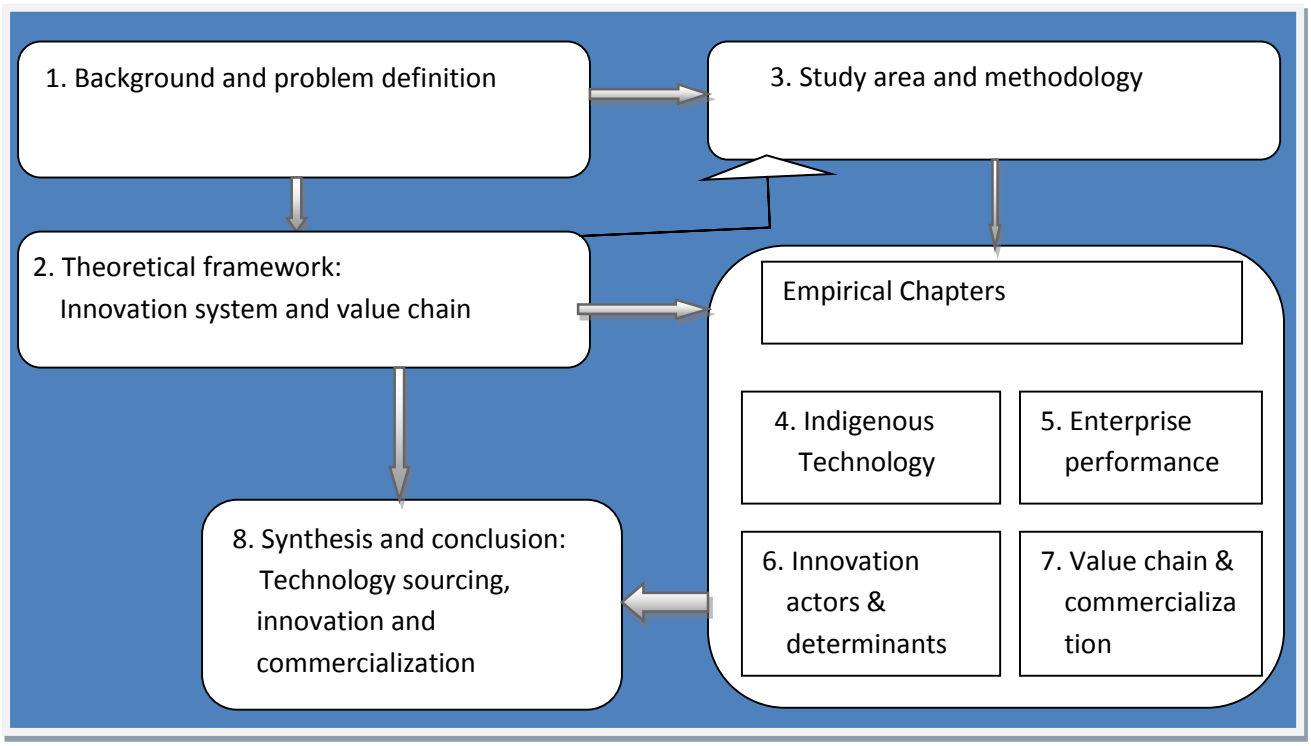


Figure 1.1:Schematic presentation of the thesis outline

2 Theoretical Analysis: Systems of Innovation and Value Chain Development

2.1 Introduction

This study applies the system of innovation (SI[3]) framework and the value chain approach are used to analyze economics of innovation and development of a product or service (Edquist 2010, 2013; Van Dirk and Trienkens, 2012). They both have structure (actors) and functions (activities) (Kaplinsky and Morris 2001; Lundvall 2010; Edquist 2013). SI focuses on innovation within a specific territory or processes in a firm while value chain analysis emphasizes market based interactions along the production and consumption system.

SI is used in such a way that the key constructs of the theory are applied with adaptations to sectors in a developing country context. This was necessary as the system of innovation approach was originally developed for advancing innovations and firms in developed countries. Though there are arguments as to whether the SI is applicable in the context of developing countries, the fathers of the systems of innovation affirm its applicability and produce voluminous literature on how to apply it (Altenburg 2009; Lundvall 2009; Edquist 2010; McCormick 2007). Lundvall et al. (2009) highlight that the system of innovation can be used to analyze innovation processes in various settings and scales of analysis. Similarly, Porter (1990), though he did not use the term 'system of innovation'; Porter's analysis of innovation in regional clusters to enhance absorptive capacity and competence of firms and regions through interaction and learning has similarity with SI. Studies have shown that the innovation system approach can contribute to enhancing endogenous competency and technology absorptive capacity of nations or organizations (Mowery and Oxley 1995; Muchie 2003). Moreover, the science, technology and innovation policy of Ethiopia has adopted the SI approach (Betele 2014).

The value chain particularly covers issues of market related interactions, actors, functions and mode of coordination. This was necessary since the system of innovation lacks the tools to analyze markets

[3] The network of institutions, organizations, firms and individuals in the public and private sectors whose activities and interactive learning initiate, import, modify and develop new technologies and organizational systems (See detail in section 2.2.2).

(Kiggundu 2007), which is essential for this study since market development is an integral component of innovative commercialization of bamboo.

Thus, the chapter will first conceptualize the innovation and SI, followed by an analysis of SI in developing countries and the basic tenets of the value chain approach. The chapter concludes with the elaboration of major variables to be addressed in this research and diagrammatic presentation of the elements and relationships of these variables in the form of a conceptual framework.

2.2 Innovations and Systems of Innovations

2.2.1 The Concept of Innovation

Innovation is one of the most widely used concepts in academic and in daily life. The application and connotation varies significantly according to the context. It was probably for the first time defined by Schumpeter in 1934 and a number of neo-Schumpeterian scholars have used the concept without altering the main elements of his definition. This paper adopts the same concept as described in OECD (2005) with the addition of institutional innovation from Weiss (2011) and the value chain upgrading concept of Humphrey and Schmitz (2002). Therefore, the concept of innovation in this thesis encompasses the following ideas:

- Product innovation is the introduction of a good or service that is new or improved with respect to its characteristics, quality or intended uses;
- Technological (process) innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software;
- Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing;
- Organizational (entrepreneurial) innovation is the implementation of a new or improved organizational method in the firm's business practices, workplace organization or external relations to achieve savings in capital or labor or improved response to customer needs;
- Institutional innovations – these are changes in the political–institutional framework of the sector which affect the process of innovation such as regulations or incentives, joint actions supported by public or semi-public organizations, industry cluster initiatives, facilitation of carbon trading and contract farming (Weiss 2011);

- Value chain innovations: the change in the functional position of actors, chain strength and vertical and horizontal coordination of the value chain system or moving to a new sector based on the accumulation of competencies (Humphrey and Schmitz 2002; Ponte and Gibbon 2005; Cozzens and Kaplinsky 2009).

Innovation is also defined in terms of its relation to or its contribution to low income communities and developing countries. In this context, it is described as pro-poor grass-roots and inclusive innovation (Gupta 2006; Chataway et al. 2014; Heeks et al. 2014; Smith et al. 2014; OECD 2013). According to Kaplinsky (2011a), Schumpeterian innovation contributed to income inequality and poverty in the South. Therefore, an alternative approach to it is pro-poor innovation which includes the excluded and may foster social and environmental sustainability (Kaplinsky 2011a). Its aim is to enhance the participation and benefit sharing of the poor from innovation endeavors.

Based on the degree of their newness, innovations can be conceptualized as radical, when they are completely new to the market. Those innovations which are an improvement of an already existing type are called incremental innovation. Innovations can also be categorized as new to the sector, firm or market (Weiss 2011). Thus new innovations relative to a rural Ethiopian village could be an established product elsewhere in the world. The various definitions of innovation have been diagrammatically presented following Weiss (2011) in figure 2.1.

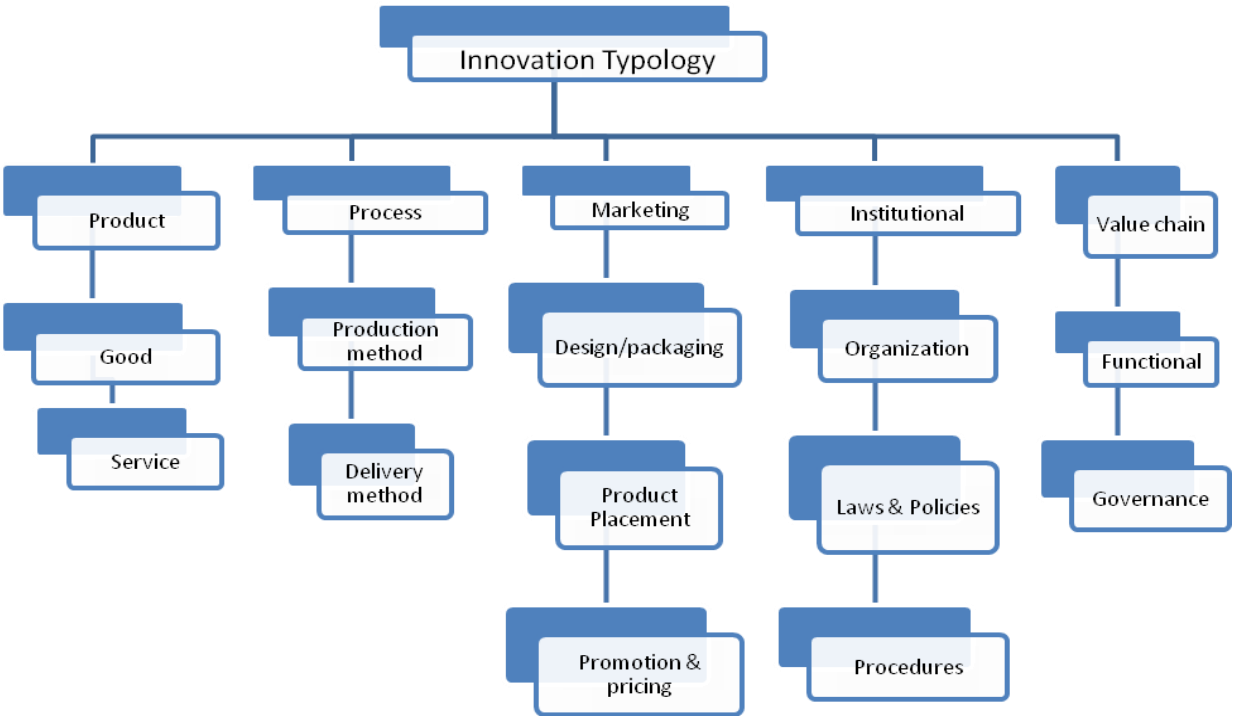


Figure 2.1: Innovation Typologies (adapted from Weiss, 2011, pp 11).

2.2.2 The Systems of Innovation

The SI is defined by several scholars. Freeman (1987 pp.1) defines it as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." Freeman's definition emphasizes the agencies, their interactions, the activities and functions of the system. Similarly, Edquist (1997 pp. 14) defines SI broadly as "all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovations". Lundvall (1992 pp 12) defines SI as "all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring", and emphasises learning and interaction as the overarching purpose of the system of innovation in the technology development process. Metcalfe (1995) defines SI as a system of interconnected institutions to create, store and transfer knowledge, skills and artifacts for production of new technologies.

SI was originally developed from systems of production theory and evolutionary theory of economics (Nelson and Winter 1982; Dosi 1982; Metcalfe 1995), both of which were built upon the Schumpeterian theory of innovation, and has become a powerful analytical tool to study innovation development and

innovation policy options recently. SI assumes that innovation is path dependent and intricately associated to and affected by institutions, organizations, social capital, knowledge sourcing and interactive learning among actors (Lundvall 2010; Edquist and Johnson 1997; Edquist 2013; Soete et al. 2010).

SI is an adaptive system and a continuous process whereby institutions (habits and practices), organizations, learning and networks play a central role in generating innovation and technological change in firms, sectors or nations (Soete et al. 2010). Its application was initially restricted at national level (Nelson 1993; Freeman 1987; Lundvall 1992) but later at regional (Asheim and Herstad 2005; Asheim 2005; Asheim and Coenen 2006) and sectoral levels (Malerba 2002, 2005b). It has been also applied along the value chain as in global value chains (Pietrobelli and Rabellotti 2011; Cozzens and Kaplinsky 2009) or clusters (Porter 1990) and industrial districts (Harrison 1992). Other scholars also studied innovation with emphasis on networks and social milieus (Camagni 1991) which emphasise political, social and political networks essential for innovation.

The theory is still evolving and boundaries are not yet delimited (Edquist 2013; Lundvall 2013). Lundvall (2010) also acknowledges that the definition is open and argues the need to maintain it open so as to accommodate possible extension and deviation from the existing body of innovation knowledge, particularly in the context of developing countries. Similarly, this open nature of the SI theory is viewed by Weiss (2011) as one of its strengths as it allows specific empirical studies to define boundaries by the specific authors themselves. He further notes that this condition is particularly relevant at least in forestry sector innovations where the intention of the system is primarily to guide analysis of innovation processes, not only within the established systems but also for those occurring in systems void. He makes this suggestion based on the empirical evidence which asserts that innovations are achieved by both established SI or random/ad hoc projects and activities (Kubeczko et al. 2006). This characteristic feature of the framework is still more essential for developing countries where virtually no systems of innovation are established at national or sectorial level than developed countries or regions. This same reason strengthens its feasibility for bamboo innovation study in Ethiopia.

2.2.3 Main elements of Systems of Innovation

According to Soete et al. (2010), SI has the following core elements: institution and organizations, technology and knowledge and actors' interaction and learning. All these elements are evident in all of the above definitions; though differing levels of emphasis are given to the elements and their functions.

Institutions occupy a central role in the SI as a facilitator and at times deterrent of innovations (Buttoud et al. 2011). Based on empirical study, they find that while institutional structures and leaderships foster innovations, other structures resist changes (Buttoud et al. 2011). Institutions are particularly important in the study of innovation for they provide insights on how actors behave in innovation processes (Edquist and Johnson 1997; Soete et al. 2010). Institutions are conceptualized in SI as habits, practices, or routines that shape the way things are done and how actors act and interact (Nelson and Winter 1982; Edquist and Johnson 1997). They can be formal or informal, basic or supportive, hard or soft and consciously or unconsciously designed rules of behavior that affect innovation processes (Edquist and Johnson 1997). The specific purposes of institutions in SI according to Edquist and Johnson (1997) are the provision of information to reduce uncertainty and to manage conflicts and cooperation, and the provision of pecuniary and non-pecuniary incentives. In addition to the formal institutions, Soete et al. (2010) has also emphasized the role of informal institutions, such as social capital, for nurturing trust among the innovative actors.

Most innovation processes are conducted in an organizational environment and it is a crucial aspect for success. It is the tangible and legally identifiable parts of the system that facilitate the innovation process through bringing actors together (Edquist and Johnson 1997). Organizations perform innovation activities while institutions guide, incentivize or influence behavior (Edquist 2013). The key private organization in an innovation process is the firm or enterprise (Edquist 2013). Firms need to have the capacity to identify sources of knowledge, absorb external knowledge and stimulate internal knowledge production. Universities, research institutes and professional associations are public organizations supporting innovation activities (Edquist 2013).

The sourcing and application of knowledge and technology is another building block of SI. Knowledge and technology may not necessarily be only of a technical nature from R&D but also a range of knowledge types from producers, distributors and consumers (Godin 2006; Soete et al. 2010; Lundvall 2010). In his analysis of user-producer interactions in SI, Lundvall (1992) noted the significance and usefulness of R&D and non-R&D sources of knowledge and technology for innovation. Similarly, Romer (1990) affirms that endogenous technologies and human capital are the most important sources of innovation. Kim (1997, 1999) and Grossman and Helpman (1991) emphasized the various forms of transferred technologies as the basis of innovation and technology development. It is also reported as the main element of forestry sector innovations (Weiss et al. 2011; Weiss 2011). Several other authors recommend context based

blending of endogenous and transferred technologies as a basis for innovation (Fu et al. 2011; Eaton and Kortum 1999).

In general, although there could be relative differences in the usefulness of and degree of application of the different sources, which in turn depend on the nations' knowledge reserve and the innovation context, the various sources provide the knowledge input that is essential for innovation to take place. For instance, foreign sources of knowledge and technologies are more important for poor than rich countries, which are what one expects given the differences in domestic R&D investments (Keller 2004).

In an SI there is continous interaction and learning among actors. According to Lundvall (2009), innovation is the result of the synthesis of knowledge produced or obtained through an interactive process of collaboration. In fact a basic feature of all innovation system is the fact that firms rarely, if ever, innovate alone (Edquist 2005; Soete et al. 2010). Conversely, non-interaction and lack of coordination between the parties result in low innovation performance (Soete et al. 2010).

The theory of innovation built by Lundvall (2010) emphasizes the need for interactive learning. He said that SI is virtually constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge (Lundvall 2010). He argues that not only knowledge but also a continuous learning (learning by interacting and doing) are essential for the system to function. Finally, innovation theoreticians elaborated the importance of cultural elements, especially social capital and networks, as essential elements of SI (Soete et al. 2010; Tsai and Ghoshal 1998; Landry et al. 2002; Zak and Knack 2001). Therefore, the interplay between these elements of SI determines the success or failure of innovation in a sector or nation. The main elements and relationship of SI is presented in figure 2.2.

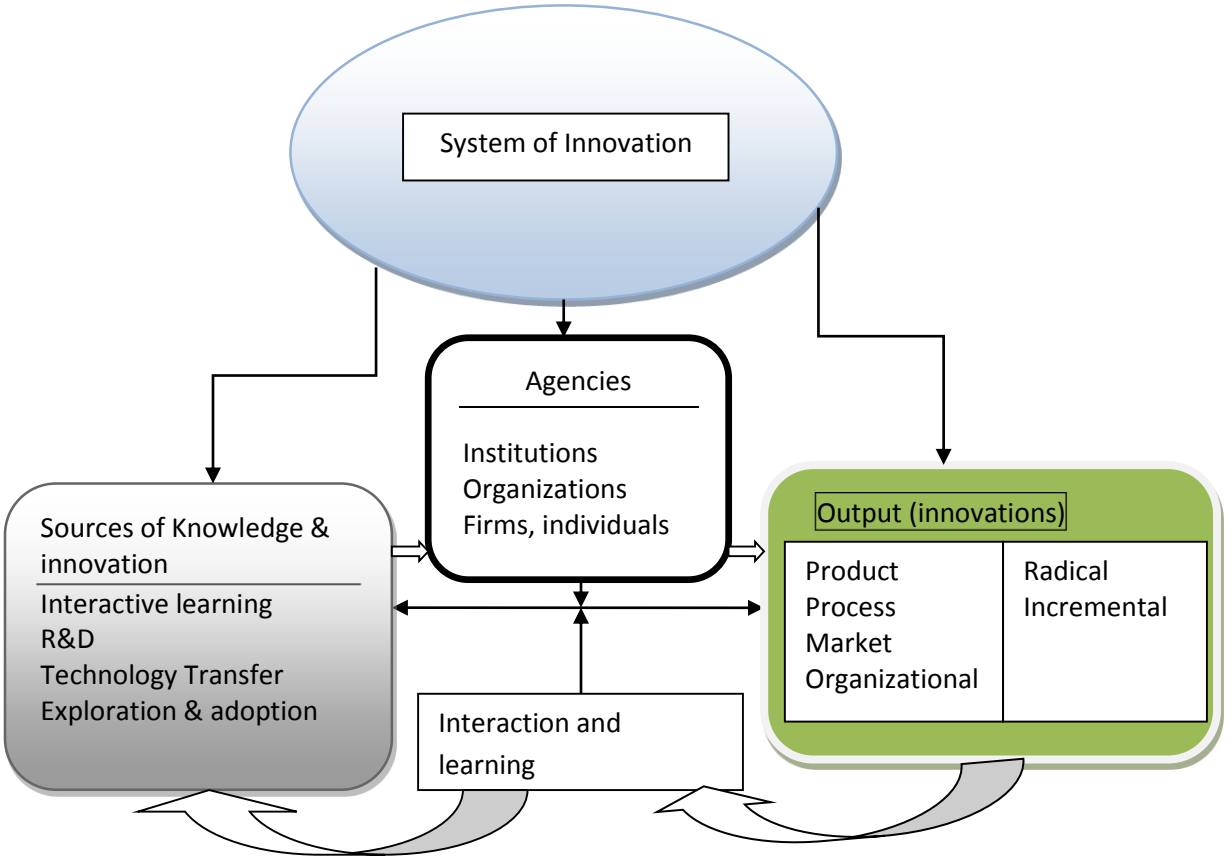


Figure 2.2: Summary of the main elements and relationship of the concepts of SI (adapted from Soete et al, 2010; Lundvall, 1992; Edquist, 2013).

Systems of innovation have functions and activities. The main functions are the production, communication and use of innovations (Edquist 2013). The activities are the creation of knowledge and the development of competency at various scales. These may include the provision of training and education, the production and facilitation of interactive learning, searching or creation of market, and creating or developing organizations and policy guides for innovation (Edquist and Johnson 1997; Edquist 2004; Hekkert et al. 2007; Lundvall 2010; Edquist 2013). Moreover, SI has activities related to the creation of market networks and non-market institutions such as clustering or incubating practices to allow firms to grow and innovate by creating fertile environments (Edquist 2004; Hekkert et al. 2007). These latter activities are particularly important for innovative firms in developing countries.

2.2.4 Sectoral System of Innovation

The sectoral system of innovation (SSI) approach has been adapted from the SI approach as an analytical framework to explain within-sector and across-sector interactions of innovation agents and sector specific processes in innovation (Malerba and Mani 2009). The SSI is understood as a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the production and sale of those products (Malerba 2002). A sector is defined as a set of activities that are unified by linked product groups for a given or emerging demand which share common knowledge (Malerba 2005b; Malerba 2005a).

Sectors have peculiarities that may affect innovation processes due to their differences in sources of innovation, processes, actors, institutions and policies (Weiss 2011; Malerba and Nelson 2011; Malerba 2005b). According to Pavitt (1984), sectors could be (i) supplier dominated where new technologies are embedded in machines and equipment and which are diffused through learning by doing, or (ii) science based,characterized by high rates of innovation from the sector's own R&D. According to Weiss (2011) forest sector innovation is largely supplier dominated as it adopts technologies mainly developed in other sectors.

The SSI largely adopts the elements of SI, and is categorized into three major building blocks of sectoral systems of innovation: knowledge and technology, actors and their networks and institutions (Malerba 2004; Malerba 2005a). However, it (i) emphasizes supply as well as demand in the innovation process; (ii) recognizes the amorphousness and dynamism of sectoral boundaries; and (iii) focuses on the process of transformation of the system (Malerba 2005a). Thus, this framework recognizes that sectors are dynamic and that perhaps new sectors may be born as innovation continues to advance (Malerba 2005a).

Innovation in forestry, like any sector, has a sectoral dimension and can therefore be analyzed based on sectoral SI (Weiss 2011; Kubeczko et al. 2006). According to Weiss (2011), the sectoral approach is preferable for the analysis of forest product value chains while the regional innovation systems are more appropriate for studying ecosystem services and recreation activities which have territorially based relationships. Thus, it is possible to use SSI as a theoretical lens to analyze the bamboo sector of Ethiopia along the value chain as affected by knowledge, technologies, market and non-market institutions. However, the theory is not well evolved from SI, and the building blocks of the theories are more or less the same. Moreover, SSI has less rigor than SI for analysis of actors and processes that cross disciplinary lines which is often the case in bamboo sector of Ethiopia.

Similarly, although the agricultural system of innovation (ASI) falls within the sectoral system of innovation, and bamboo is a forest and agricultural product, the thesis does not draw much from agricultural innovation systems. This is because the agricultural system of innovation largely focuses on production level innovation with less emphasis on the role of intermediaries and enterprises in the agribusiness sector. To this end, the ASI and its variants are less applicable for analysis of bamboo innovation and commercialization where the primary focus is analysis of value addition and capability constraint of actors beyond production level.

2.3 Innovations in Developing Countries and Sources of Technology

2.3.1 Innovation in Developing Countries

While the basic tenet of the systems of innovation is the same, there are differences in national institutions, infrastructural condition and the technological capability of actors between developing and developed countries. One of the key objectives of innovation in the former regions is to build a knowledge base and core competencies (Bell and Pavitt 1997; Muchie et al. 2003; Djeflat 2013). Their second objective is to advance social development through inclusive innovation (Klochikhin 2012; OECD 2013). Inclusive innovations are pro-poor and are appropriate to address the innovation needs of developing countries (Heeks et al. 2014; Kaplinsky 2011a). However, developing countries often fail to achieve their objectives since the vicious circle of poverty and low economic development limits investment in innovative capacities and institutions (Altenburg 2009; Bell 2007; Bartels et al. 2012). Moreover, markets are not encouraging for innovation in these regions (Bell and Pavitt 1997; Pietrobelli and Rabellotti 2011). For Chaminade et al. (2009) and Chaminade and Pérez (2015), the problems are systemic and related to capability, networks and institutions.

Altenburg (2009) has further elaborated the problems and barriers hindering system building in developing countries as: (i) innovation is not their priority compared to poverty reduction and universal education; (ii) formal institutions where enforcement is usually weak and arbitrary despite their crucial role in innovation; (iii) less effective and accountable governments and (iv) firms are less interested in innovation and have low levels of specialization and interaction. Similarly, Pietrobelli and Rabellotti (2011) have identified related but additional obstacles for innovation in developing countries. According to these scholars, most innovations in developing countries are (i) based on non-R&D knowledge sources and the type of innovations produced are mostly incremental, (ii) key science and technology organizations may not exist or are inadequate, and linkages among them and with local firms are often weak, (iii) the

organizations that are important are those providing technology diffusion and extension services, (iv) transfer of knowledge and technology from external sources is more essential for innovation and learning in developing than developed countries.

Features and challenges of innovation more particular to Africa are elaborated by several scholar (E.g. Muchie et al. 2003; Muchie 2013; Rose 2012; Wamae and Kraemer-Mbula 2010; Oyelaran-Oyeyinka and McCormick 2007). Most of the analyses, though to a varying degree, are related to low technological capability, low absorptive capacity and weak institutional systems. Ethiopia is not an exception and in measures such as production and foreign technology absorption capacity, it is reported as lower than most African countries (Etzkowitz and Roest 2008). As a result, the key component of the system in this region is to build a knowledge base and the capability to drive innovation. Consequently, recent studies are largely focusing on building systems and competencies crucial for identifying, absorbing and exploiting local and foreign knowledge and technologies for national and sectoral innovation development.

To this end, the following subsections discuss the major theoretical issues about sources of technology and knowledge, acquisition mechanisms and process challenges that may also be applicable for innovation in the bamboo sector of Ethiopia.

2.3.2 Technology Transfer and Absorptive Capacity

Technology transfer (TT) is a mechanism to raise the knowledge and technology base of an organization, firm or country through the acquisition and effective assimilation of outside technology. It is more important for low income countries where the locally based learning sources and mechanisms are relatively weak and are unable to support important types of capability building independently (Bell 2009). According to Keller (2004), transferred technologies are the major sources of domestic productivity improvement for most developing countries and determine the extent of technical changes and the expansion of technological frontiers. It has also been reported that technology transfer is one of the important elements for building indigenous technological capability and catch up processes of countries of Asia (Kim 1999).

Technology can be transferred from an external source through foreign direct investment (FDI), import/export trade, international R&D, official development assistance (ODA), temporary movement of people or Diaspora returnees, contract research, consultancy, purchase of capital goods and machine embodied technologies (Kim 1999; Hoekman et al. 2005; Hoekman and Javorcik 2006b; Bell 2007). Among these, FDI is one of the most studied and dominant channels of technology transfer (Saggi 2006).

Depending on the level of incentives offered and restrictions imposed, their effect on technology transfer and spill-over to local firms can be higher or lower (Moran 2004; Hoekman et al. 2005; Saggi 2006). However, authors argue that empirical evidence is thin (Saggi 2006; Keller 2004). Moreover, the spillover effect of FDI is dependent, among other things, on absorptive capacity of the recipient (Altenburg 2009; World Bank 2008). Trade is another channel of TT. When nations import capital goods and machineries, technologies could be transferred embodied within goods that are imported and these provide the opportunity for local firms to learn through reverse engineering (Hoekman and Javorcik 2006a; Kim 1999). As a result, openness in trade is often considered as one of the factors facilitating or deterring TT (Henry et al. 2009; Keller 2004).

In both FDI and trade based TT, technologies can be transferred with or without market mediation (Kim 1999). In market mediated transfer, the supplier and the buyer negotiate payment for the technology transfer while in the case of non-market mediated technology transfer, suppliers have more influence on how the technology is transferred and used by recipients (Kim 1999). Developing countries with strong absorptive capacity can effectively acquire foreign technologies, informally without market transaction costs (Kim 1993). Conversely, developing countries with low economy and low absorptive capacity[4] may achieve low levels of technology transfer (Glass and Saggi 1998). Glass and Saggi (1998) analysis can be interpreted in such a way that not only do these countries fail to buy technologies because of their weak economy, but they are also not in a position to assimilate freely available technologies because of their limited technological capabilities.

Technology transfer has three levels: (i) the transfer of capital goods, equipment and machineries; (ii) the transfer of skill and know-how for operating and maintaining machines and equipment, and (iii) the transfer of knowledge and expertise for generating and managing technological change (Bell 2007). The impact of the transfer of machines and equipment is restricted to improving productivity, as dependence on foreign skills for maintenance and operational correctness remains. The transfer of basic operational and maintenance skills increases the efficiency of foreign technologies. The basic and challenging stages of the transfer are acquiring the knowledge and expertise required for generating the technologies and changing them as appropriate (Bell 2009). In a similar line of argument Kim (1999), asserts that in the early stages of industrialization, developing countries acquire mature technologies in packaged form, which

[4] It is defined as the ability to recognize the value of new, external information and technology, assimilate it, and apply it (Cohen and Levinthal 1990).

includes assembly process, product specifications, product know-how, technical personnel and components and parts. At this stage, firms in developing countries produce merely an assembly of undifferentiated products using foreign inputs (Kim 1999). Later, with increased competition and increased indigenous technical effort, this transferred technology supports the production of relatively differentiated products which he calls duplicative imitations. With substantial investment in R&D and effective learning, this can evolve to creative imitation and may eventually result in the ability to generate their own radical innovations (Kim 1999).

Although TT is one of the options for the industrialization of developing countries, there is no guarantee for the successful transfer of technology. Success can be affected by selection of technology, institutional and policy condition, and the possession of knowledge and learning capabilities of the recipients (Bell 2007; Douthwaite et al. 2001; Shin 1996). Moreover, the willingness and capacity of foreign firms determines the spillover effects of foreign technology (Park, 2011; Farole and Winkler 2014a). Technology spillovers are more likely when the technological capability of local firms is sufficient to understand and adopt the technologies used by foreign affiliates: in those cases, local firms can use existing knowledge to adapt and adjust foreign technologies for their own purposes (Chen et al. 2011). Rates of transfer can also be affected by technological gaps between recipient and source countries (Chen et al. 2011).

Moreover, the tacitness and sticky nature of technology and the presence of organizational routines poses comprehension and replication difficulties in the process of technology transfer (Polanyi 2012; Nelson and Winter 1982; Leonard-Barton 1998; Howells 1996; Szulanski 1996; Criscuolo et al. 2005; Bogers et al. 2010). The partially codified nature of technology means that technology diffusion will be incomplete; meaning, the codified part will be easily transferred while the tacit component of a technology may remain within the host (Keller, 2004). The tacit component, which is acquired via the informal take-up learning behavior and procedures, can be transferred. However, the transfer mechanisms are generally associated with personally embodied acquisition patterns rooted in direct on-site learning and experience sharing (Howells 1996) and usually take greater engagement than acquiring codified knowledge or technology. Moreover, tacit knowledge is largely informal and formalization is often difficult as it requires coding. Therefore, informal practices such as intuition, serendipity and craft skills which have a large tacit component have still an important role in modern innovation processes (Howells 1996).

TT is also affected by proximity of the technology sources and receivers (Keller, 2004). Proximity could be geographical/spatial (Torre 2014), organizational or cognitive (Uzunidis 2008). The organizational proximity may refer to market or hierarchical, intra or extra-firm. Moreover, Uzunidis (2008) argues that

innovations are produced in an economic environment of a region developed over the course of history ('path dependence'). It is a product of interactions between firms, institutions and labor. "Such interactions are exclusively the result of mutual synergies (networks, partnerships, and so on) between different local agents (public or private) participating in economic and industrial development." (Uzunidis 2008, PP. 191).

TT is also critically influenced by the absorptive capacity of the firm (Qian and Acs 2013). It is defined by Cohen and Levinthal (1990) as the ability to recognize the value of new, external information and technology, assimilate it, and apply it. It is the ability to effectively receive and assimilate technology and is highly dependent on the qualities and assets the receiver firm or country possess (Zahra and George 2002; Wamae 2013). It is dependent on prior knowledge of firms and individuals (Cohen and Levinthal 1990) as well as the intensity of technological learning efforts (Lall 2001; Lall and Kraemer-Mbula 2005). Absorptive capacities could be studied at individual or organizational level. Individual capacity is usually expressed as human capital, while organizational capacity refers to the firm level capability to absorb external knowledge which, in turn, is a function of individual absorptive capacity and system efficiency (Cohen and Levinthal 1990). Cohen and Levinthal (1990) emphasizes that organizational absorptive capacity is more than the sum of individual absorptive capacities though the former is dependent on the latter. They also argue that absorptive capacity is path-dependent and lack of continuous investment in an area of education may foreclose the future development of a technical capability in that area. Related but further elaborated conceptualization of absorptive capacity was made by Zahra and George (2002) as organizational routines and processes, by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability. Mowery and Oxley (1995) also define it with emphasis on the tacit component of knowledge as a broad set of skills needed to deal with the tacit knowledge transfer and the need to modify this imported knowledge. Castellacci and Natera (2013) conceptualized it as having five attributes: human capital, openness to international trade, infrastructure, quality of institutions and social cohesion and trust.

Absorptive capacity is also related to national innovation systems. Countries that have benefited most from inward technology transfer have national innovation systems that have strengthened their 'national absorptive capacity' (Mowery and Oxley 1995). Conversely, innovation is driven by the synergy between investment in absorptive capacity and investment in sources of technology (foreign technology) (Liu and White 1997). Absorptive capacity plays a critical role in closing the technological gap during catch up and the development of innovative capabilities in developing countries (Hu and Mathews 2005).

Active involvement in TT process improves absorptive capacity. According to Glass and Saggi (1998), countries with low economies may have low absorptive capacity at the beginning of industrialization, and hence a low level of TT efficiency. Similarly, Heijs (2012) highlights that firms with a low innovative level have a comparatively lower learning capability than the more innovative firms. However, gradual absorption of foreign technologies enhances their absorptive capacity in such a way that initially they imitate low quality technology and later high-quality technologies as their absorptive capacity is strengthened (Glass and Saggi 1998). Therefore, absorptive capacity is a dynamic capability which could be gradually improved through engagement in TT and indigenous capacity building efforts.

Despite recent study that is more focused on systemic models of innovation development with emphasis on endogenous knowledge and competency building, the role of TT is still undisputed and there is no substitute for countries like Ethiopia where endogenous capacity is low and technology building institutes are still scant. Even among developing countries, Ethiopia ranks only next to Chad in technology production and absorption (Etzkowitz and Roest 2008). Therefore, while there may be no disagreement about its important in the bamboo sector of Ethiopia, the challenge is how to cope with the complexity and knottiness of TT with a low level of absorptive capacity. Furthermore, the analysis of TT is not to choose between indigenous and foreign technologies, rather to provide a theoretical base on which to blend them together to facilitate the development of bamboo innovation by local firms. A summary of possible sources and determinants of TT is presented in figure 2.3.

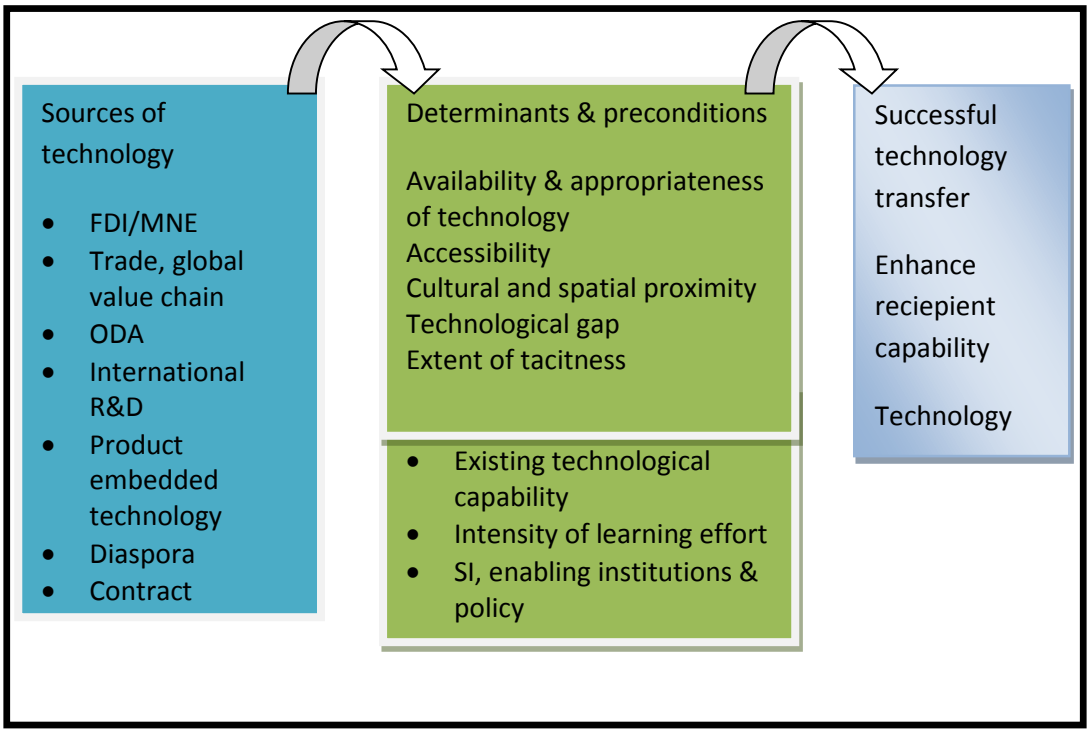


Figure 2.3: Technology Sources, Success factors and impacts of TT.

2.3.3 Endogenous Sources of Knowledge and Technology

According to the theory of innovation development in firms by Schumpeter, innovations are an endogenous process. Rist et al. (2014), conceptualized it as knowledge generated from within, but unlike their argument, that it is synonymous with indigenous knowledge, this thesis uses the term to embrace all national knowledge sources[5]. As discussed above, countries may require external knowledge and technologies for economic growth and competitiveness. However, countries or firms cannot compete by adopting external technologies alone (Liu and White 1997). Moreover, the benefits of external technology can only be delivered with parallel endogenous innovation efforts (Fu et al. 2011; Dutrenit 2004). As a result, the theory of innovation development considers innovations as an endogenous process (Sengupta 2014). Therefore, broadening the scope of technological capability of a nation beyond absorption capacity

[5]In this thesis the term endogenous refers to all knowledge originated from national sources (traditional knowledge, R&D, local enterprises or clusters as opposed to foreign sources)

for foreign technology, this subsection presents a theoretical discussion about local sources of knowledge and technology for creating innovation.

Indigenous Knowledge and Technology

One of the local sources of knowledge and technology for developing countries is indigenous knowledge and technologies. It is very crucial especially for grass-root innovations (Borthakur and Singh, 2012). Indigenous knowledge is the sum of the experiences and knowledge of a given social group and hence often is associated with a certain space and community (Dei et al. 2000). According to Hoppers (2003, pp 10), indigenous knowledge is characterized by its embeddedness in the cultural web and history of people, and constitutes tangible and intangibles aspects that can be identified as those that: (i) have exchange value and that , with support, can be transformed into enterprise or industries; (ii) perpetuate social, cultural, scientific, philosophical and technological knowledge that can provide the basis for development; and (iii) represent major socio-cultural, institutional and organizational systems. As can be seen in the above characterization, because of its embededness and holistic nature, distinction between knowledge, skill (techniques) and beliefs is often difficult to make.

UNESCO (1998) defines indigenous knowledge and local knowledge as the cumulative and complex bodies of knowledge, know-how, practices and representations that are maintained and developed by local communities, who have long histories of interaction with the natural environment. Similarly, Siyanbola (2012) define it as the mature longstanding traditions and practices of certain regional, indigenous or local communities as well as the wisdom, knowledge, and teachings of these communities and listed the following basic features: (1) It is centered on local or indigenous peoples and their beliefs or practices; (2) It is generally bound by geography in that the knowledge, most often, does not transcend the locality where it originates; (3) It is generally tacit in nature, being most times orally passed from person to person, for generations; and (4) It is not dated in the sense that the knowledge or practices do not necessarily have to be primordial.

Another definition focuses on its dynamism and acknowledgement of diverse sources of knowledge in contrast to the usual definition where knowledge transfers from heir to offspring. In this definition, it is understood as a unique formulation of knowledge coming from a range of sources rooted in local cultures, a dynamic and ever changing past 'tradition' and present invention with a view to the future (Sillitoe 2006). It is rather a blend of knowledge resulting from the constant interaction with the surrounding community which is often difficult to disentangle. It is dynamic and there is no as such "traditional" knowledge (Sillitoe

2006). According to him, indigenous and modern knowledge passes constantly and possibly equally within both knowledge systems. Doughty (2005) argues that stewardship over indigenous knowledge does not and should not mean hermetically sealing indigenous culture off from the influences and vicissitudes of external knowledge systems. He rather reiterates that indigenous knowledge must come into contact with other knowledge systems and develop towards a contemporary purpose (Doughty 2005). Similarly, Kraemer-Mbula and Wamae (2010) has also described it as a resource coexisting and interacting with scientific knowledge.

Sillitoe (1998) while acknowledging the coexistence and interaction, argues that the two knowledge systems are distributed unevenly and exist in a continuum where the "uneducated rural farmer" who relies on indigenous knowledge stands on the one hand and the elite usually with scientific knowledge in the other extreme. According to Sillitoe (2006), in between, there exist various intergradations of local insider and global outsider knowledge depending on community of origin and formal education. He further argues that in a community there are those who received formal schooling, and have a passing acquaintance with science, which they will blend with their locally derived knowledge and cultural heritage. Similarly, a portion of the farmers may get the opportunity for extension education (Sillitoe 2006). Therefore, interactions are likely available and one influence the other in the process.

It is found that this knowledge system is less theorized. Studies of indigenous knowledge largely focus on their preservation and recognition (Dutfield 2006), rather than on how to enhance their technological application for development. Moreover, although there are theoretical studies emphasizing the need for possible integration with scientific knowledge and innovation system building (Bell 2007; Kraemer-Mbula and Wamae 2010; Muchie 2013), how it can be done is still overlooked.

There are, however, a couple of best cases which could be a base to conceptualize theoretical integration and practical applications. The honey-bee innovation network of India is one such example where broad efforts have been made to document enormous numbers of grass-root innovations and enhance the contribution of indigenous knowledge to technological development in the respective localities (Gupta 2006; Srinivas and Sutz 2008). Several of them has been recognized as contributing to modern pharmaceutical and biotechnology development (Siyanbola 2012).The second example is the successful commercialization of non-timber forest products by integrating indigenous knowledge and modern technologies in China (Zhaohua and Chunqian 2001).

Local Clusters as Sources of Knowledge and Centers of Innovation

Clusters are defined as geographic agglomerations of interconnected companies, specialized suppliers, service providers, and related institutions in a particular field and region (Porter 2000). Clusters are adequately covered in literature as providing technological and knowledge spill over (Porter 1990; Schmitz 2007; Parrilli and Asheim 2012); leveraging complementarities and improving economies of scale (Porter 1990; Yoshino 2011); accumulation and application of appropriate technologies (Caniëls and Romijn 2003); mitigation of entry barriers for capital through intra-industrial credit linkages (Ruan and Zhang 2009); easing transfer of tacit knowledge and application of technology (Fu et al. 2011). As a result, they are promoted in many developing countries for knowledge accumulation, resource mobilization and capacity development.

Clusters, when used as instruments for knowledge based linkage and centers of production, are often viewed as a reduced level of system of innovation (Roelandt 2001). They are an effective tool to facilitate knowledge based interactions and knowledge accumulation at the local and micro-levels (Diyamett 2012). Diyamett (2012) attributed clustering as an effective way to build systems of innovation at the micro-level. Innovation building clusters are information networks that comprise enterprises, non-profit organizations and institutions (Viitamo 2001).

Clustering is also associated with regional systems of innovation and competitive advantage. Despite the fact that globalization facilitated information flows globally, the competitive advantages in a global economy still largely lie in local resources—knowledge, relationships, motivations—that distant rivals hardly access (Porter and Millar 1998). The premise for clustering is that close inter-firm communication, familiar socio-cultural structures and institutional environments stimulate socially and territorially embedded collective learning and continuous innovation a little faster than firms outside of the region or locality (Asheim and Isaksen 2002; Yu and Jackson 2011). According to Asheim and Isaksen (2002), a regional innovation system is a developed form of regional cluster with a formal network among firms and facilitated with strong institutional infrastructures. Similarly, spatial proximity and its effectiveness to exploit tacit knowledge is a justification for the development of regional systems of innovation (Kubeczko et al. 2006). Thus, clusters are closely related to and are the stepping stones for the formation of a well-developed (regional) innovation system.

Therefore, development of clusters is increasingly seen as a basis for developing innovation systems in developing countries (McCormick 2007; Diyamett 2012). Moreover, despite the emphasis given here on its relation to and contribution for innovation, they are also an effective instrument for facilitating business transactions in value chains (Viitamo 2001; Yoshino 2011; Spielman).

Local Research and Development (R&D)

Local R&D is the other source of knowledge and technology for innovation development. The development of local capability through local research and development systems not only helps to institutionalize learning and technology accumulation but also facilitates technology transfer and assimilation (Hu et al. 2005; Dai and Yu 2013). Similarly, Criscuolo and Narula (2008); Rosenberg (1990); Kinoshita (2001), find that local R&D efforts and acquired capabilities can help an enterprise to understand and assimilate technological developments in other enterprises and research institutions.

Endogenous technological change through the development of a variety of inputs and machines used in production generated by local research and development organizations is one of the many models used to analyze technological change and economic development (Romer 1990). The assumption is that local R&D will lead to the development of new machines or inputs for production (process innovation) (Romer 1990), and new or improved varieties of products (product innovation) (Grossman and Helpman, 1991). Unlike proponents of endogenous technological effort as prime source of knowledge for innovation such as (Romer 1990), advocates of foreign technology based catch up argue that latecomers can skip the cost of R&D by using readymade technologies from foreign sources (Awate et al. 2012; Kumaraswamy et al. 2012). For these scholars, TT is cost-free while R&D is expensive and depletes the meager resources of developing countries. In reality, both options have visible and invisible costs.

Although there are arguments about which direction to prioritize, own technology development or technology transfer, a large number of authors seem to favor the need for in-house technological developments by investing in human capital and R&D as critical for developing original innovations as well as for absorbing technologies transferred from external agencies (Sun and Du 2010; Liu 2014; Fu and Gong 2011; Liu 2007 #334}. This is always subjective, however, in that, local R&D will interact with external sources and idea generated locally may have its sources outside of the firm or nation. According to Dai and Yu (2013) while emerging economies can acquire technologies during exportation, those with relatively lower export intensity and who are far behind the international technological standards need to invest even more on accumulation of in-house technological efforts in order to cultivate, assimilate or adapt the knowledge they need for innovation and international competition. Therefore, R&D is crucial to innovation development irrespective of a country's economic and technological level. However, for the development of bamboo innovation which this thesis envisions, R&D has limited impact in the short-term. As a result, its relevance and validity can be discussed mainly based on experiences from countries with developed bamboo R&D.

2.4 Innovation in the Bamboo Sector and Role of Institutional Actors

In the introduction, a review of bamboo resources and utilization has been made. In this section, the global innovation, value chain and role of institutions is briefly discussed. The global bamboo value chain in comparison to the small thriving value chain of Ethiopian bamboo is largely obtained from well managed stands, and products are well integrated in global markets (Hogarth and Belcher 2013; Hogarth 2013; Mertens et al. 2008; Hoogendoorn and Andrew Benton 2014). Despite its late start, bamboo innovation has transformed fast from small subsistence or craft production from cottage industries to high quality, diversified products produced in high technology industry establishments. Starting in the 1940s with the production of mat boards in China and at about the same time in India and its diversifications in type and quality over the years, the bamboo innovation took off in the 1980s (Hoogendoorn and Andrew Benton 2014; Vengala et al. 2008; Shyamasundar and Vengala; INBAR 2014). Innovations in engineered bamboo, an important milestone in improving the strength and workability of bamboo, have grown particularly rapidly since this time (Ramage et al. 2014; Mulligan et al. 2014; Mahdavi et al. 2011; Sinha et al. 2014; Gatóo et al. 2014). Similarly, the production of coiled bamboo products in several Asian countries has also been included in the bamboo product category. Innovative developments in the preservation of bamboo have been registered in several countries (Liese and Kumar 2003; Liese 2005; Manalo and Acda 2009; Fattah et al. 2014). Innovation of bamboo charcoal and value added products are also new developments in Asia and have been transferred to Africa (Hoogendoorn and Andrew Benton 2014). Innovations in bamboo charcoal and its value added products have increased the diversity of bamboo products from construction related uses to the chemical and pharmaceutical industries. This is because charcoal production produces a large number of chemicals useful in different industries. Bamboo product design innovation and engineering for facilitating commercialization is also underway in Europe (van der Lugt 2008; Gatóo et al. 2014).

Despite these global developments in bamboo innovation, the Ethiopian bamboo sector is still thriving largely as a craft sector. To stimulate the innovation process at this initial stage, the role of government and other supporting institutions involved in the study of bamboo innovation seems relevant due to two major reasons. First, the current development trend in Ethiopia is government dominated and private enterprises are largely weaker players compared to the state enterprises (Altenburg 2010; Etzkowitz and Roest 2008). Moreover, despite the clear need, bamboo is not yet supported by guiding development policy.

Secondly, bamboo innovation and commercialization in China has succeeded through government, company and farmer collaboration (Zhaohua, Z., 2008). Government has developed a land use policy that guarantees bamboo farmers to use state owned land and develop bamboo plantations. Farmers have been given an exclusive right to manage and use the returns. The government also facilitates the collaboration between farmers and companies. Farmers were incentivized for semi-processing the bamboo and companies benefit with the reduced cost due to the fact that bulk transport is avoided. The government has also supported companies in searching markets for their products. The government established a number of bamboo research centers which work at all stages of bamboo production and consumption systems. Companies expanded their processing technology and improved their global competitiveness and become the dominant bamboo processors in the world (Zehui et al. 2012).

This review can be summarized that Chinese bamboo was developed through the establishment of a system of innovation (by a dynamic collaboration of companies, state and farmers). State agencies and institutions are a core component of their bamboo innovation (Zhaohua 2008). Moreover, it is noted that development in bamboo technology is based on indigenous technology and craft culture (JiangXi Bamboo 2010). For instance, bamboo was a standard writing material around 200 BC and was used to make household articles around 1040 BC (JiangXi Bamboo 2010). Recently, they have also supported it with local R&D (Zehui et al. 2012). Therefore, there are available bamboo technologies and experience in organizational innovations for which Ethiopia may import and apply for developing its technology and business organization relevant for bamboo commercialization.

2.5 Summary

The very purpose of systems of innovation is to facilitate the production of innovation in products and organizational processes. For this to happen, the development of national, firm and individual levels of capacity is essential. The various sources of knowledge and technology described above are primarily aimed at enhancing the innovation capacity of actors. It is particularly important for African countries where the system of innovation is a system under construction (Muchie 2003; Lundvall 2009). While some of the structures are there, the critical linkages and the institutional set-ups that are needed to facilitate innovation, are missing or still weak and fragmented (Szogs et al. 2011; Muchie 2013). Therefore, identifying knowledge sources and building capabilities for innovation is argued in this thesis as one of the core components of bamboo commercialization and sector development. The knowledge and capabilities could be gained from indigenous sources, local R & D or developed via education, vocational and on-job trainings (Borras and Edquist 2014). It can be also gained or strengthened by external knowledge and

technology. For the latter, firms need to have effective absorptive capacity to understand availability, imitability and the extent of tacitness of external knowledge for successful internalization and adoption of technical knowledge (Katz 1984).

Innovativeness of firms in developing countries is hindered by market scarcity and requires greater market relationship between actors along the production chain. Moreover, the chain of actors and their interaction can be another avenue for innovation knowledge and information. Therefore, the value chain approach and its main elements (function of actors, benefit distribution, governance and upgrading issues) of the chain are discussed as part of the theoretical framework of bamboo commercialization.

2.6 The Value Chain Approach

2.6.1 Introduction

Value chain approach can be used to analyze the various elements of value chains depending on the purpose of the study. It may be used to analyze actors (suppliers, intermediaries, processors and consumers), benefit distribution, coordination and upgrading mechanisms. Although bamboo products originating in Ethiopia constitute an underutilized resource and do not have a developed value chain, some of its features could nonetheless be analyzed using the value chain approach. Moreover, value chain analysis can be used to analyze options for entry in global value chain such as the development of technological capability of firms (Morrison et al. 2008; Pietrobelli and Rabellotti 2011; Webber and Labaste 2010) , appropriate mode of coordination (Humphrey and Schmitz 2004; Gereffi et al. 2005; Schmitz 2004), chain upgrading (Mitchell and Coles 2011; Trienekens and van Dijk 2012; Humphrey and Schmitz 2004) and identification of major constraints (van Dijk and Trienekens 2012; Meaton et al. 2013).

2.6.2 The Concept and Genesis of Value Chain

Approaches explaining relationships of firms to their respective production systems has increased since the 1970s when firms increasingly outsourced part of their activities and firm boundaries became more blurred (Altenburg 2006). The most common among these types of relationships is the chain concept. However, the chain concept itself has also many variants based on disciplinary (sectoral) focus and geographic location of chain origins (Altenburg 2006; Bair 2009; van Dijk and Trienekens 2012). However, they all seek to capture and describe the complex interactions of firms and processes that are needed to create and deliver products to end users (Webber and Labaste 2010). The most common of all them especially in development and economic literatures is the value chain.

The value chain is defined as the full range of activities which are required to bring a product or service from conception through the intermediary phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers and final disposal after use (Kaplinsky and Morris 2001). Thus, it is a chain of activities to create and transfer values (materials), information and knowledge where the behavior of actors in the chain is governed by market and/or other forces of coordination. The value chain also allows analysis of the distribution of benefits along the chain (Ribot 1998; Talbot 2009; Poschen et al. 2014). Most value chain conceptualization incorporates the structures (actors and institutions), functions (activities), benefit distribution and coordination mechanisms.

Value chains could range from those which add values to the system to those which do not do so but simply connect different regimes of values (Crang et al. 2013). Moreover, they can be win-win which facilitates commercialization to enhance the employment condition, income and livelihood of communities at the grass roots level while at the same time securing a sustainable, even flow of quality products for consumers (Kaplinsky 2000). They can also be an exploitative type for some of the actors in the value chain depending on the governance structure and the negotiation power of the actors. From the perspective of spatial coverage, they can operate globally as in global value chain or act specifically in a locality or region. However, the chains are dynamic and cannot indefinitely remain local.

The value chain has its early genesis from the filiere concept (Ribot 1998; Bair 2009). This was developed to analyze agricultural production from Africa to fulfill colonial interests (Raikes et al. 2000). The second origin is the global commodity chain. It is developed by the Anglophone group (Gray Gereffi and his colleagues) and largely focused on the analysis of industrial production chains during the 1960s to 1980s (Raikes et al. 2000). The third origin is the supply chain concept which originates in the business management discipline developed and highly elaborated by Michael Porter in the 1980s. All of these concepts are rooted in the world systems of production and marketing, though they also draw on concepts from other theories such as transaction cost theory, the new institutional economics, and global networks, among others (Sturgeon 2001; Bair 2009; Sturgeon 2009; Trienekens 2012).

Development economists accepted the value chain concept as an overarching tool to analyze production and marketing relationships (Bair 2009). Its analytical rigor is dependent on the concept of governance, chain upgrading, economic rent and its systemic and dynamic nature (Humphrey and Schmitz 2000). The systemic nature is largely dealt in the SI. A brief analysis of governance and upgrading will be made in this section.

2.6.3 Value Chain Governance

One of the major elements of the value chain approach is the governance of the system (Gereffi et al. 2005; Altenburg 2006; Schmitz 2006; Bair 2009). It is the process of coordinating the physical flow of products and services, information and finance in the value chain. Coordination refers to the harmonization of the functions of a value chain –better coordination leads to better matching of demand and supply leading to efficient, low-cost exchange and value addition (Anandajayasekeram and Gebremedhin 2009).

The governance in a value chain captures the variations in organizational arrangements in firm- firm interactions, particularly focused on how lead firms (producer and buyers) drive the system (Sturgeon 2009; Gereffi et al. 2005). The producers have higher influence on capital intensive value chains while labour intensive value chains tend to be governed predominantly by buyers from abroad or through intermediaries (Sturgeon 2009). In the later type of value chain, buyers take the lead initiative and influence product specifications which are common for agricultural product value chains from developing countries (Anandajayasekeram and Gebremedhin 2009).

Gereffi et al. (2005) developed an elaborate analysis of value chain governance. According to them, five different types of governance typologies have been identified. These are market, modular, relational, captive and hierarchical. Classification is based on coordination tools, power asymmetry, complexity of inter-firm interaction and the capability of suppliers to fulfill buyers' requirements. The business relations of firms in the various governance systems are determined by (a) the complexity and the amount of information and specifications required to sustain a particular transaction; (b) the extent to which such information and knowledge can be codified and transferred efficiently; and (c) the capability of suppliers to handle transactions. The governance of the value chain also affects the intensity of the flow of knowledge and other information. This in turn affects the level of innovativeness of the value chain actors at the various stages (Cozzens and Kaplinsky 2009).

Several studies emphasize the need for addressing the peculiarities of agricultural value chains and their respective governance arrangements in developing countries (Ribot 1998; Trienekens 2012). According to Talbot (2009), the main feature of tropical value chains is that their governance can be highly controlled by actors other than those directly within the value chain. Similarly, Raynolds (2004) indicates that agri-food chains in this region are highly regulated by states. Other studies also show that states could be critical players in value chains (Gellert 2003; Humphrey 2006; Bair 2014).

2.6.4 Value Chain Upgrading

The term upgrading is defined as the capacity of a supplying firm to learn from global buyers to innovate and, thus, acquire new functions from pure manufacturing to design (Giuliani et al. 2005; Jean 2014). It is often used to describe the mechanisms which suppliers in developing countries use to move up the value chain (Ponte and Ewert 2009; Coles and Michell 2011). According to Humphrey and Schmitz (2000), it is a firm strategy to keep up with competition either by producing the same product more efficiently or moving to a stage where they can be more competitive. Gereffi (1999) defines industrial upgrading as a process of improving the ability of a firm or an economy to move to more profitable and/or technologically sophisticated capital and skill-intensive economic niches. With his analysis on the interaction of firms along the industrial gradient, Gereffi (1999) argues that participation in the global value chain is essential for industrial upgrading because it puts firms and their economies on potentially dynamic learning curves. He further argues that the linkages (backward with supply sources and forward with marketers) are the micro-foundations of learning to upgrade.

Firms can follow different types of upgrading trajectories (Kaplinsky et al. 2009; Coles 2011). These are: (i) product upgrading: involving the production of new products through changing the approach for new product development within individual links in the chain and the entire relationships of chain; (ii) process upgrading: refers to the improvement of internal efficiency of firms within individual links in the chain and between the links for transforming input to output better than competitors; (iii) functional upgrading: increasing added value by changing the mix of activities inside the firm or by outsourcing some of the activities to a different link in the value chain, or taking a new value chain function; and (iv) chain upgrading: this is the process of moving to another value chain or sector after developing core competencies in another value chain. Bolwig et al. (2011), emphasizes the upgrading strategies in relation to the institutional and governance frameworks than the previous theorists.

However, upgrading of suppliers or producers is often constrained by a barrier to entry (Kaplinsky and Morris 2001). This is because suppliers who attempt to move upwards, especially in buyer-driven value chains, often face high barriers to entry, due to their lack of control of design, distribution, marketing, or other activities (Bair 2005; Humphrey 2014; Humphrey and Schmitz 2002; Selwyn 2014). In a situation where producers/suppliers lack adequate capability to produce products or services required for upgrading, they are often stuck at a low level of production and face stiff competition that is based on low cost and thin margins (Ivarsson and Alvstam 2010).

Although there is no significant attempt to enter in the global bamboo value chain by Ethiopian bamboo enterprises, it is expected that entry to global value chains will be challenged by established companies with advanced production technology and firm organization. However, there are also cases where lead firms help suppliers to upgrade to fulfill their product quality requirements (Ivarsson and Alvstam 2010; Kaplinsky et al. 2009).

2.7 Conceptual Framework: the Need to Integrate SI and Value Chain Approach

The primary focus of SI is on knowledge enhancing processes, technologies, actors and institutions. Although innovation literature covers market (demand) as a pull factor (Dosi 1982, 1988) for innovation and argue that it deals with market-enhancing institutions (Lundvall et al. 2009), and in some cases as one element of user producer interactions (Lundvall 2010), its emphasis on market relationships is low compared to that on knowledge and technologies. According to (Altenburg et al. 2008; Altenburg 2009), innovation system rarely explores the importance of markets and market enhancing institutions thoroughly and systematically. He further elaborates that with its focus on non-market institutions, the innovation system risks losing sight of innovation enhancing institutions such as competition, governance and regulation of firm entry and exists into a system (Altenburg 2009). These are areas in which the value chain analysis essentially provides adequate emphasis. Moreover, in addition to the role of value chain in analyzing and also facilitating market linkages, which serves as an incentive for firms to engage in innovation, value chain related interactions themselves are seen as a source of knowledge and learning for innovation (Flint et al. 2008; Bakhshi and McVittie 2009; Fu et al. 2011; Morrison et al. 2008). The proponents of this idea also argue that in each of the steps of the supply chain, there is interaction which leads to the occurrence of innovation (Sundbo 2011). Thus, actors in the supply chain are involved as knowledge producers, process facilitators or input providers to produce innovation at one point in the value chain (Sundbo 2011). This is particularly important in developing countries since sources of learning are limited within value chains or regions. Therefore, access to knowledge downstream or upstream through the value chain increases the knowledge that can be an input for innovation. Due to these delicate interactions, a middle ground is in the making (Kaplinsky 2011b).

However, it is equally important to note that while the value chain system that promotes product markets and actor relations along the chain is one of the constituents of a well-functioning system of innovation, not all market relationships promote innovation development. The nature of the market and the way the market based relationship is governed largely affect the outcome. For instance, (Lundvall 1985) states that both pure market and pure hierarchal value chain governance have narrow limits for the promotion

of product innovation even if there is strong producer-user interaction. Similarly, it is argued that the value chain relationship may not yield innovation if unequal power relationships exist in the system (Cozzens and Kaplinsky 2009).

Although the value chain approach is better at explaining relationships in production - consumption systems of a product or service, actor functions, including value creation and appropriation, flow of material and information, governance and dynamic development (Kaplinsky 2011b; Pietrobelli and Rabellotti 2011), it does not fully explain knowledge identification, acquisition, assimilation and the role of technology at the various stages of a value chain. Moreover, it does not clearly show whether or not each upgrading stage dictates a different form of learning and pattern of behavior (Kiggundu 2007). Moreover, value chain scholars defined innovation value chains largely in terms of upgrading. However, value chain upgrading can be carried out as an activity or achieved as an outcome without innovation. Upgrading also has the tendency to underemphasize the novelty of the approaches or processes followed to achieve the goal. It does however recognize the relative performance of the firm with regard to apgrading activities of competitors (Kaplinsky et al. 2002). Value chain innovation for this thesis refers to a new way of transformation or improvement of existing value chains from those which are poorly operating, with limited networks ending in local market to those with global reach and interconnected webs of actors and processes.

In summary, system of innovation has strong emphasis on technology, learning and institutions for innovation while value chain approach emphasis on market based interactions, governance and chain upgrading. Therefore, for innovative commercialization of bamboo in Ethiopia where production is low technology based and not well integrated in the market economy, application of SI along with the value chain approach provides a strong theoretical base for analyzing innovation processes and their market integration.

With this line of justification, a diagrammatic conceptual framework is constructed drawing key concepts and their relationship to the elements of systems of innovation in developing countries and relevant components of the value chain approach (Figure 2.4).

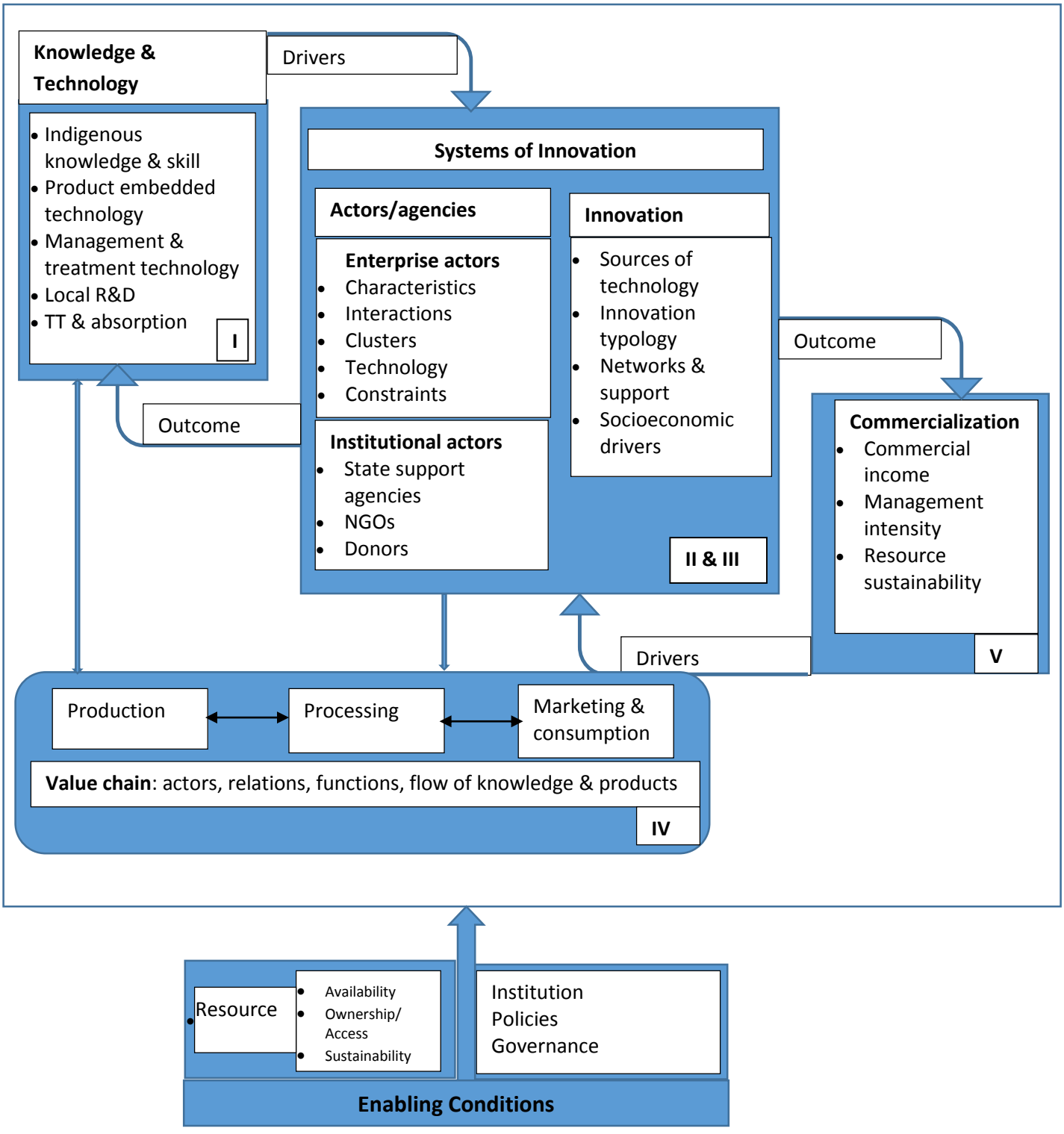


Figure 2.4: The conceptual framework for the analysis of bamboo innovation and commercialization in Ethiopia (own compilation).

3 Research Setting and Methodological Approach

3.1 Introduction

In the previous chapters, the study problem and the theoretical basis for the study were discussed. Based on the problems and the operational research questions, this part of the thesis will present the methodological approaches and techniques applied to collect relevant data and the methods employed for analyzing the various data sets collected. Relevant justifications for the choice of methods and techniques are also presented. Prior to the description of study methods, the study setting including the national economic and technology policy conditions are described.

3.2 Overview of Biophysical and Socioeconomic Setting of Ethiopia

3.2.1 Biophysical Setting

This study is conducted in Ethiopia, which is located in North East Africa bordered by Kenya, Sudan, Eritrea, Djibouti and Somalia. Latitudinally and longitudinally, it is located between 6^0 and 33^0 North and 15^0 and 48^0 degree east of the Greenwich meridian respectively. Ethiopia has a total area of about 1.13 million square kilometer and forest cover constitutes about 11% of the land area (FAO 2010). The population of the country is estimated as 88 million (CSA 2013).

Ethiopia has a diversity of relief features ranging from high mountains to deep gorges. The highest regions such at Ras Dashen and Tulu Dimtu have altitudes of 4620 m and 4377 m above sea level respectively. These regions are cold and frequently register temperatures below zero. On the other hand, there are places like Dallol depression which is about 120 m below sea level which is one of the hottest places in the world. In between there exists a diversity of physiographic features.

In addition to mountain chains, plains and plateaus, the largest part of the Great Rift Valley is located in Ethiopia and dissects the country into eastern and western mountain massifs and creates another feature to contribute to the diversity of life forms in Ethiopia. Thus, owing to the combined effect of physiographic, edaphic and climatic factors, the Ethiopian landscape harbors a range of vegetation resources, from tropical rain and cloud forest in southwest Ethiopia to the desert scrubs in the east and northeast and a large diversity of agroforestry in the central plateaus (Friis et al. 2010; Teketay et al. 2010). These forest resources are however heavily degraded due to agricultural expansion, cattle grazing and wood material collection (Teketay et al. 2010; Lemenih and Kassa 2014).

The majority of the Ethiopian landmass has slopes greater than 10%, a condition potentially suitable for the expansion of perennial crop production rather than cereal crops. Moreover, since bamboo naturally occupies plains, leeside of mountains, river banks and marshy areas, many of the relief features of Ethiopia with these features could be conducive for the expansion of the resource beyond its current range.

3.2.2 Socioeconomic Setting

Ethiopia is the second most populous country in Sub-Sahara Africa with a young and fast growing population. It is one of the least developed countries in the world with GDP/capita of around $570 (IMF 2014). However, it is one of the fastest growing economies in the world (World Bank 2015). Agriculture is still the main stay of the economy contributing about 43% of national gross domestic product (GDP) and two-third of merchandize export earnings (Dorosh and Rashid 2013; World Bank 2010). It is dominated by subsistence smallholder farmers most of whom have a cultivable land area of less than 0.5 hectare (Admassie and Abebaw 2014). Land is owned by the state and farmers have use rights to their farm holdings (Rahmato 2008).

Ethiopia has low technology industries dominantly engaged in the production of simple agro-processing and consumer goods (Altenburg 2010). Industries that could support the accumulation of technological capability and create dynamic inter-firm linkages are scant and overall technological capacity of firms is low even compared with other Sub-Sahara African countries (Altenburg 2010; Fenta 2014). Compared to the national economic growth (9.7%), which is largely brought about by agriculture and the service sector, the industry grows relatively fast (18.5%). However, its overall contribution to total national growth was only 2% which indicates that it still has a small share in the economy (Wold Bank 2014). The contribution of agriculture is decreasing recently which is compensated by a similar increase in the service sector (Altenburg 2010). Similarly, the merchandize export earning of Ethiopia is one of the lowest in the world owing to its low value addition, poor quality products and small number of firms involved in this sector (Wold Bank 2014).

3.2.3 The Policy Setting

Ethiopia had started building modern institutions and policies early in the 20th century (Altenburg 2010). However, they were continuously changed due to political unrest and ideological shifts. The first industrial policy which was market led was issued during the imperial era (Gebreeyesus 2013), and was immediately

changed when the Derg (a military government) come to power. This government followed a command economy and nationalized all major private holdings without compensation (Table 3.2).

After the downfall of the military government in 1991, the transitional and the subsequent federal government implemented a number of policy reforms to institute a different mode of economic development approach (Gebreeyesus 2013). The government's primary focus and policy priority was to reduce poverty and achieve agriculture based economic development. The first major economic strategy document towards this goal was the agricultural development led industrialization (ADLI) (Admassie and Abebaw 2014). ADLI was the foundation of the economic policy of the country for several years starting in 1992 (Dorosh and Rashid 2013). Within this framework, two national plans were developed to reduce poverty and meet the millennium development goals (Admassie and Abebaw 2014). The strategy had little impact until 2000. Beginning in 2001, economic growth was registered, notably in the agriculture sector. However, overdependence on agriculture has later brought structural constraints arising from low emphasis on the other sectors of the economy (Admassie and Abebaw 2014).

In response to this and also as a logical progression of the development plan from an agriculture to an industry led economy, the country developed an ambitious growth and transformation plan (GTP) in 2010. This plan represents the overarching national development strategy and encompasses the policies and strategies of all sectors of the country. In order to attain structural transformation from agriculture to industry, the document gives due attention to the expansion of the industrial sector and development of capability to run the industry (MoFED 2010). To this end, policies and strategies are revitalized or improved and consequently, organizational structures are reshuffled.

The industrial policy recognizes the role of the private sector but emphasizes the importance of state leadership to support and challenge these enterprises (Altenburg 2010; Gebreeyesus 2013). Furthermore, the policy attempts to address failures by supporting priority sectors and providing institutional leverage for their competetiveness. The main priorities of the government are export oriented companies and sectors (e.g. leather, textiles and flowers).

In line with the industrial development strategy, the old science and technology policy which was issued in 1993 has been replaced with a more comprehensive policy document in 2011. The new policy is intended to serve as a framework to identify national science and technology priorities, strategies, programs and projects to support the different economic and service sectors (MOST 2012). The policy envisages the establishment and strengthening of functioning research and development organizational

structures; allocation of 1.5% of the national GDP to science and technology; and the development of national competency for developing indigenous technology as well as adoption and adaptation of foreign technologies. Similarly, in order to respond to organizational demand, the science and technology agency was upgraded to ministry level. Research institutes which were within other organizations were included within the organizational structure of this ministry.

Table 3.1: Comparison of Ethiopian industrial policy in three governments

Characterizing feature	Imperial period (pre-1974)	The Derg regime (1975-91)	The EPRDF regime (post 1992)
Guiding policy	Market oriented	Command economy	Market oriented
Public/private role	Private-led	State-led	Private-led but also strong state
Ownership structure	Dominance of foreign owned enterprises	Dominance of public owned enterprise	Dominance of domestic privately owned enterprises
Target industries	Import substituting and labor intensive industries (e.g. Textile, food, cement)	Import substituting and labor intensive industries but also basic industries	Export oriented & labor intensive industries (e.g. Textile, leather, agro-processing, cement)
Envisaged key player	Foreign investment	Public sector investment	Domestic private sector
Policy instruments	Protection of domestic market through high tariff and banning of certain imports	Protection of domestic market through high tariff and quantitative restrictions	Direct support for selected export sectors through capacity building and other means
	Provision of economic incentives & preferential credit scheme	Financing, subsidizing, ensuring monopoly power for the SOEs	Provision of economic incentives & preferential credit scheme

Source: (Gebreeyesus 2013, pp 4).

Moreover, the government has issued other policies and strategies to address capability constraints in industry and R&D. The first is the shift of tertiary education away from the dominance of social science towards science and engineering. In the previous years, the proportion of natural science vs social science majors was not regulated by law. However, in 2009, the government proclaimed that science and engineering should constitute 70% of the total university enrollment. This was a major policy decision to prepare human resource in science and engineering for the planned industry based economy. The second is the development of technical and vocational educations targeting the priority industries and economic sectors. Finally, the government recognizes technological learning from foreign firms as another strategy to reduce the short term impact and enhance indigenous capability in the long-term.

Therefore, at least in terms of policy provision and its willingness to reform relevant organizational structures, it seems that the government demonstrates support to the development of science, technology and innovation systems. However, a study about the industrial policy environment of Ethiopia by (Altenburg 2010), notes the absence of an independent evaluation system to monitor the policy's performance. Moreover, although different levels of policy support are reported in the policy document for several sectors, it is reported that the private sector which is supposed to be the engine of industrial development are still weak players (World Bank 2013). According to the (World Bank 2013), public investment rate of Ethiopia is the third highest in the world, while the private investment rate is the sixth lowest. There are also criticisms that the policy is biased towards export-industries and puts little emphasis on import substitution (Altenburg 2010).

3.2.4 Enterprises and Support Systems

The majority of firms operating in Ethiopia are categorized as micro and small enterprises. It has been reported that 1.3 million persons were engaged in the micro enterprise manufacturing sector, about 94% of which are own account workers (Altenburg 2010) and about 25% of them are small-scale wood and furniture manufacturing enterprises (Gebreeyesus 2013). These enterprises are working with small amounts of capital often for survival. They are largely dependent on production of consumption goods and services; where 55% engaged in food and beverages, and 23% textiles and garments (Altenburg 2010). Most of them are informal (70%) (World Bank 2009) and are ephemeral, 60% of firms exit in the first three years after entry (Gebreeyesus 2008).

Large enterprises are very small in number and absorb only a very small share of Ethiopian workforce (Altenburg 2010). In terms of value added, larger firms contribute more than small firms (Gebreeyesus 2013). For instance, from 2008/08 budget year, large firm's accounts for about 83 percent of manufacturing value added products in comparison to micro-firms which contribute 11 percent (Gebreeyesus 2013).

Many of the large enterprises are state owned (Gebreeyesus 2013). There are also endowment firms, foreign owned firms and private firms (largely by Diaspora Ethiopians) that could be categorized as large firms based on their capital and employee number (Altenburg 2010). Private owned firms are generally less competitive and weaker compared to the others listed (Altenburg 2010).

Unlike in many other countries, small and medium enterprises of Ethiopia are weaker, contributing to only 10% in employment based on data from 2007/08 budget year (Gebreeyesus 2013) and low level of value additions compared to large enterprises. In order to change the low level of enterprise performance in general and the SMEs in particular, the government of Ethiopia has shown increasing interest and developed schemes to support them through provision of credit, training and working space (Gebreeyesus and Mohnen 2013). In policy terms, the government reiterates the need to support different levels of enterprises and has issued development strategy documents for the various enterprise types. For the micro-enterprises, it issued the national micro and small enterprises strategy in 1997 and established the Federal micro and small enterprise development agency (FeMSEDA) as an implementing organization in 1998 and amended in 2004 (Gebreeyesus and Mohnen 2013). Similarly, the government has developed schemes to support larger enterprises in terms of capacity building, tax incentives and holistic support schemes especially for export oriented enterprises. Moreover, the role of vocational training institutes has been scaled up to support micro enterprises.

However, Gebreeyesus and Mohnen (2013) found that only eight percent of all enterprises surveyed reported that they have received government support. Moreover, private local entrepreneurs complain of unfair competition, alleging that state-owned, endowment-owned, and even foreign enterprises have better access to land, credit, foreign exchange and support services (Altenburg 2010; World Bank 2009).

3.3 Selection and Description of Study Districts and Cities

3.3.1 Selection of Study Areas

The rural districts are selected due to a number of reasons. Two of the three study sites have been pilot sites for bamboo technology development and commercialization while Sheka, a non-pilot site, is taken for comparison purpose. Awi and Sidama have managed bamboo production system whereas Sheka bamboo forest stands. All study sites are among the major bamboo growing regions, though have different craft production and utilization culture, intensity of household consumption and level of market integration. Except Sheka, the other two are major suppliers of bamboo raw material for existing bamboo processing enterprises. Finally, the author has greater experience in Sheka and Sidama while Awi is located in accessible area which facilitates data collection in short time.

The cities are selected for they are the major consumers of commercial bamboo resource and the main traditional bamboo craft processing centers. Moreover, they are the centers of government and non-governmental organizations involved in bamboo development and promotion. Thus, the selected regions

are more or less representative of Ethiopian bamboo growing and processing regions and hence provide useful comparative insight about bamboo innovation and commercialization.

3.3.2 Study Districts

The selected case districts in rural area are Awi, in the northwestern: Sheka, in the southwestern and Sidama, in south-central part of Ethiopia which more or less represent the remaining growing areas (Figure 1). Within the districts, the major bamboo producing *Kebeles* (smallest political administration units in Ethiopia) are selected. The *Kebeles* more or less lies in the same agroecological and altitudinal location roughly ranging between 2000-3000 m.a.s.l. A separate description of the major socio-cultural and biophysical features of the study cases is briefly presented below (Endalamaw et al. 2013).

Sidama

Sidama is one of the administration zones of the Southern Nations, Nationalities and Peoples regional state (SNNPRS) with a total population of 2,954,136 and land area of 7672 km^2 (Endalamaw et al. 2013; CSA 2007). It is located within $5^0$45'-$6^0$45' N latitude and 38^0-39^0 E longitude with an altitudinal range of 500 – 3500 m.a.s.l. Average annual temperature ranges from 15-20°C and rainfall between 800-1200 mm. Generally the highlands are cooler and moister than the mid or low altitude parts of the region. The areas above 2000 m.a.s.l. (highlands) are generally suitable for bamboo growing. Bamboo grows as part of an agroforstry system in the district. The major agricultural crops in Sidama include coffee, enset, chat, sugarcane, beans, maize, wheat, barley and several vegetables and fruit occupying specific agroecological niches along the altitudinal gradient. Eucalyptus, podocarpus and other highland tree species are found in the same agro-ecological zones with highland bamboo in this region (Endalamaw et al. 2013).

The Sidama is well connected to the main high standard road to the capital except remote highlands which have only gravel roads. Hawassa, which is the capital of Sidama and the regional state SNNRS, is a dynamic city with higher density of educated population and center for local and international tourists is located in this district. The Kebeles where data is collected is found 145 km from Hawassa (Endalamaw et al. 2013).

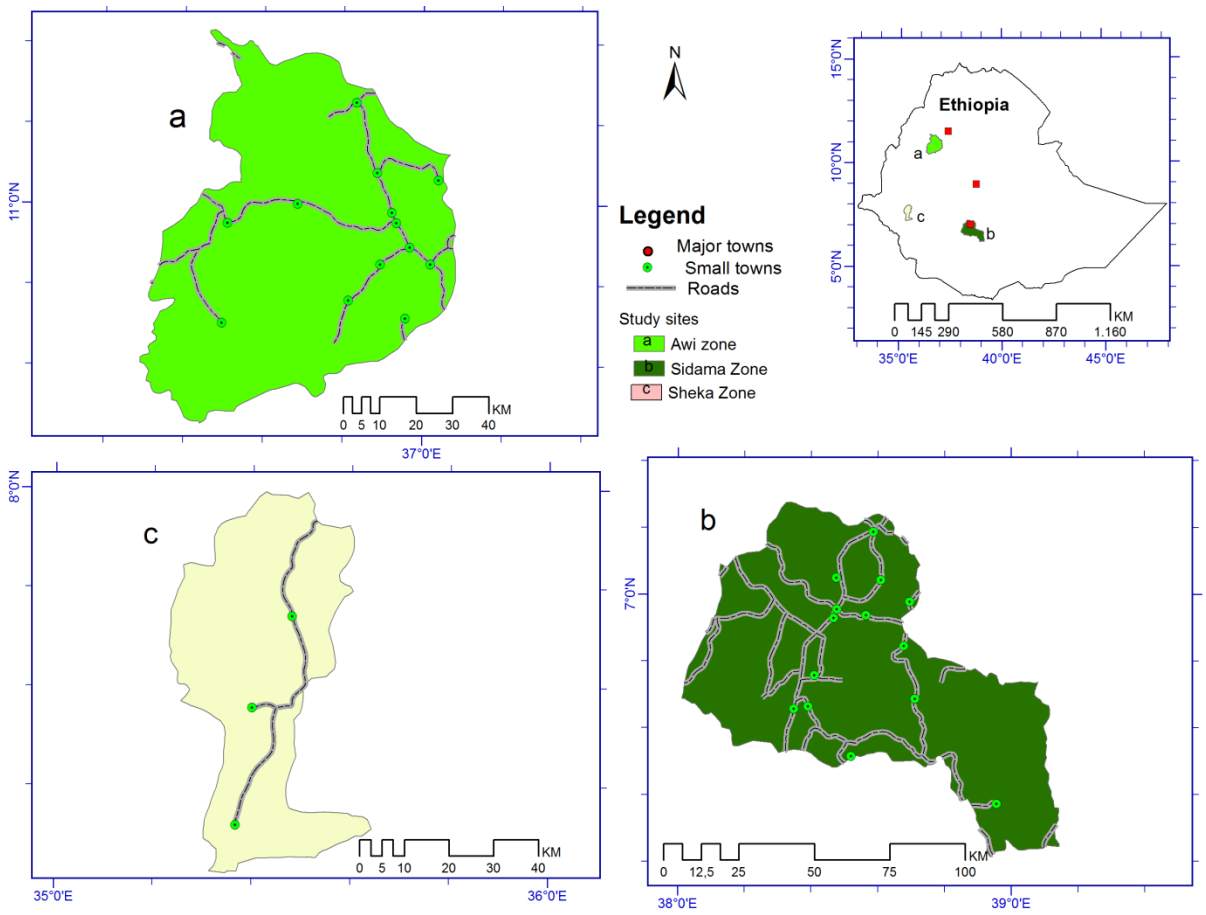


Figure 3.1: Location of the study areas (source: Endalamaw et al, 2013).

Awi

Awi is one of the administrative zones of the Amhara regional state of Ethiopia. It is located $10^0$27'and $11^0$25' N latitude $36^0$17' and $37^0$4' E longitude with an altitudinal rage of 1900- 3300 m.a.s.l. and average temperature of about 18°C and rain fall of 2206 mm (Endalamaw et al. 2013). The population of the district is 982,942 (CSA 2007). The majority of this district is cooler with abundant bimodial rainfall. Bamboo grows in the highlands and lowlands. As in Sidama, eucalyptus grows in the same agro-ecological range with bamboo and found plots and strips of mixed and adjacent bamboo and eucalyptus plots in this district (Endalamaw et al. 2013).

Awi is situated on the highway from Addis Ababa to Bahir Dar, another flourishing city in the northwestern part of the country. Thus it is well networked by all-weather roads and communities can easily transport their products to market or consumption centres. Moreover, although Awi is relatively distant from Addis Ababa with 445 km, it is surrounded by other cities such as Bahir Dar (120 km), Debremarkos (284 km),

Gondar (300 km) in addition to Injebara town, which is located in Awi. Awi has an area of 9,148.43 square kilo meter and a population of 982,942 (CSA 2007). It is one of the of major agricultural production areas in Northwestern Ethiopia (Endalamaw et al. 2013).

Sheka

Sheka has a population of 192,970 and an area of about 2175.25 km2 (CSA 2007). Administratively it is also located within the Southern Nations, Nationalities and Peoples regional state (SNNPRS). Geographically, the Zone lies between 7°24'–7°52' N latitude and 35°13'–35°35' E longitude. The altitudinal range of the Zone falls between 900–2700 m.a.s.l., and it receives a high amount of rainfall, with an average of 1800–2200 mm annually (Woldemariam and Fetene 2007). The region is more or less homogenous where the majority receives high rainfall, in fact it is the wettest part of the country. It is the place where the last dense natural forest exists, with a forest cover of 50-60% (Wiersum et al. 2008). Bamboo is located in selected marshy areas of the forest chain above 2450 m.a.s.l. as part of the montane forest system. The stocking is of high density with 8840 culms ha−1 (Embaye et al, 2005). It is also one of the remaining mountain forest regions in the country (Woldemariam and Fetene 2007; Tadesse et al. 2014).

It is one of the remotest regions with a poor road network and limited other infrastructures that connect it with major urban centers. It is about 700 km Southwest of Addis Ababa and 350 km from the city of Jimma. Jimma is surrounded by abundant agricultural and forest product source regions and there are few traders transporting products from Sheka except honey and coffee. There are few other towns in the region that may stimulate local level trade and consumption of forest products. Agricultural practices are the sole livelihood sources for the majority of the inhabitants. Enset and maize are the major staple foods and used for household subsistence. Honey and coffee are the major cash income sources. Honey has higher importance in the higher altitude while coffee in lower altitudes (Wiersum and Endalamaw 2013). Livestock population is higher in Sheka than the other two study areas and provides both subsistence uses and cash income.

3.3.3 Study Cities

In addition to the rural districts, three cities are covered by this study. While the study of rural districts is focused on bamboo production and indigenous utilization, the study in the cities has given more emphasis on the processing enterprises, traders and consumers of raw and value added products. This was

necessary to complete the analysis of the production - consumption system and the flow of knowledge and technology along the chain. The study cities with their respective populations are Hawassa (157,879), Bahirdar (221,991) and Addis Ababa (2,739,551) (CSA 2007). These cities are the major urban bamboo resource consumption centers. Many recreational and tourist houses which use bamboo products are also found in or in the vicinities of these cities. Moreover, the majority of bamboo processors (people who convert bamboo culms to different value added products), traders and related bamboo commercialization agents are present in these cities (CSA 2007). The three cities are further described below.

Hawassa

Hawassa is the regional capital of SNNPRS where Sheka and Sidama belong. The city is also the major trading center and the biggest city in Southern Ethiopia. It is located 270 km south of Addis Ababa. It lies between 6° 83' and 7° 17'N latitude and 38° 24' to 38° 72 E' longitude (Welearegay et al. 2012). The surrounding rural areas of Sidama highland, Bale Mountains and several bamboo growing districts are the sources of bamboo raw materials for crafters in this city.

Bahir Dar

Bahir Dar is the nearest big city to Awi district. Bahir Dar is the state capital of the Amhara regional state and the major tourist destination in Northwestern Ethiopia. It shares the shore of Lake Tana, the largest lake in Ethiopia and located adjacent to the biggest falls of the Blue Nile. The city is located 500 km Northwest of Addis Ababa. The nearest bamboo raw material for bamboo processors is obtained from Awi at 120 km and the largest bamboo growing region (Beneshangul Gumuz) of Ethiopia is also found at about 300 km south of the City.

Addis Ababa

Addis Ababa is the political capital, the commercial center and the largest metropolitan city of Ethiopia with a population of more than 2.7 million (CSA 2007). Most bamboo training, promotion and support organizations are mainly found in these cities. Many other enterprises and clusters are also based in these cities. Crafters in Addis Ababa are conveniently located to obtain bamboo raw material from all over the country, the nearest being Siltie/Guragie areas, which is about 150 km South. The crafters enjoy a high diversity of consumers within the city compared to the regional crafters. Probably due to the market, the largest numbers of bamboo craft enterprises are located in this city.

3.4 Research Design

3.4.1 Introduction

This research is designed to collect data that will help to understand bamboo production technologies, innovation and commercialization processes and drivers along the value chain. Thus, it follows the procedures for collection of data along the production to consumption systems by Belcher (1995). According to Yin (2014), research design is a logical plan which guides on how the study will be conducted and analyzed to optimize the validity of the research. Thus, this section briefly describes the major variables investigated, procedures of data collection, epistemological approach and survey techniques.

3.4.2 The Research Variables

Identification and determination of study variables is crucial to adequately address the research objective. Variables for this research are drawn from the study problems and theoretical reviews. Relevant indicators for each variable under study are also determined based on operational research questions. The list of variables, indicators, methods of data collection and levels of analysis is presented in table 3.2.

Table 3.2: Summary of major issues or variables investigated, indicators and method of data acquisition at different levels of the production to consumption system.

Main issues/variables investigated	Indicator and explanatory concepts	Method of data acquisition and analysis	Level of analysis
Indigenous knowledge & technology	Proportion of skilled artisan Extent of use knowledge embedded technologies in crafts and houses Socioeconomic profiles of informants	Survey Group discussion Baseline survey by PRA tools	*Kebele* community Household
Enterprises, actors and performance	Typology (formality, modernity, size) Socioeconomic characteristics Business motivation Production technology Constraints and opportunities Bamboo supply & demand Enterprises' income & determinants of performance	Enterprise survey Group discussion Expert interview Consumer survey	(National) bamboo Enterprises
Innovation and determinants	Number , type & determinants of innovation Type & characteristics of innovative entrepreneurs Perception of innovation Networks & interactions Technologies & supports	Secondary data Expert interview Enterprise survey Group discussion Case study	(National) bamboo enterprises
Value chain structure and function	Type, number and function of actors Relation and coordination Benefit distribution	Household interview Case study Group discussions Expert interview Consumer survey	Production to consumption system
Commercialization	Commercial income Management intensity Value chain relationship and strength Socioeconomic profiles and town functions SWOT Analysis	Household survey Group discussion Baseline survey Case study	Household *Kebele* community

3.4.3 Selection of Research Approach

The type of research approach followed is dependent on the type of data required which inturn may depend on the epistemological positioning of the research problem. This research has aspects of explorative, inferential and explanatory components. As a result, it is found appropriate to use the mixed method approach (Creswell 2003). Mixed method is defined by Johnson et al. (2007, PP 123) as "… type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration". This method is increasingly accepted as a tool to find workable middle solution for many practical and theoretical research problems (Johnson et al. 2007; Creswell 2003).

3.4.4 Data Sources and Procedures of Data Collection

The research was conducted in a series of phases and procedures including review of documents, baseline surveys, requesting and gaining administrators' approvals, preparing interview questionnaires, testing them, conducting detailed interviews, case studies and analysis of the collected data set (Figure 3.2).

Data were collected from different sources of major stakeholder categories in the bamboo production-consumption continuum. After baseline survey completed, semi-structured interviews were conducted on bamboo growers and harvesters, bamboo and wood enterprises, bamboo recreational house owners and other consumers, bamboo experts and decision makers. Group discussions were conducted with bamboo producers and processors. Case studies were made on selected craft enterprises, one medium sized bamboo producing company and one bamboo recreational center. Multiple data collection techniques are preferred to understand the context and the participants with reasonably high validity (Cunningham 2001). A summary of sample size and type of data sources are presented in table 3.3.

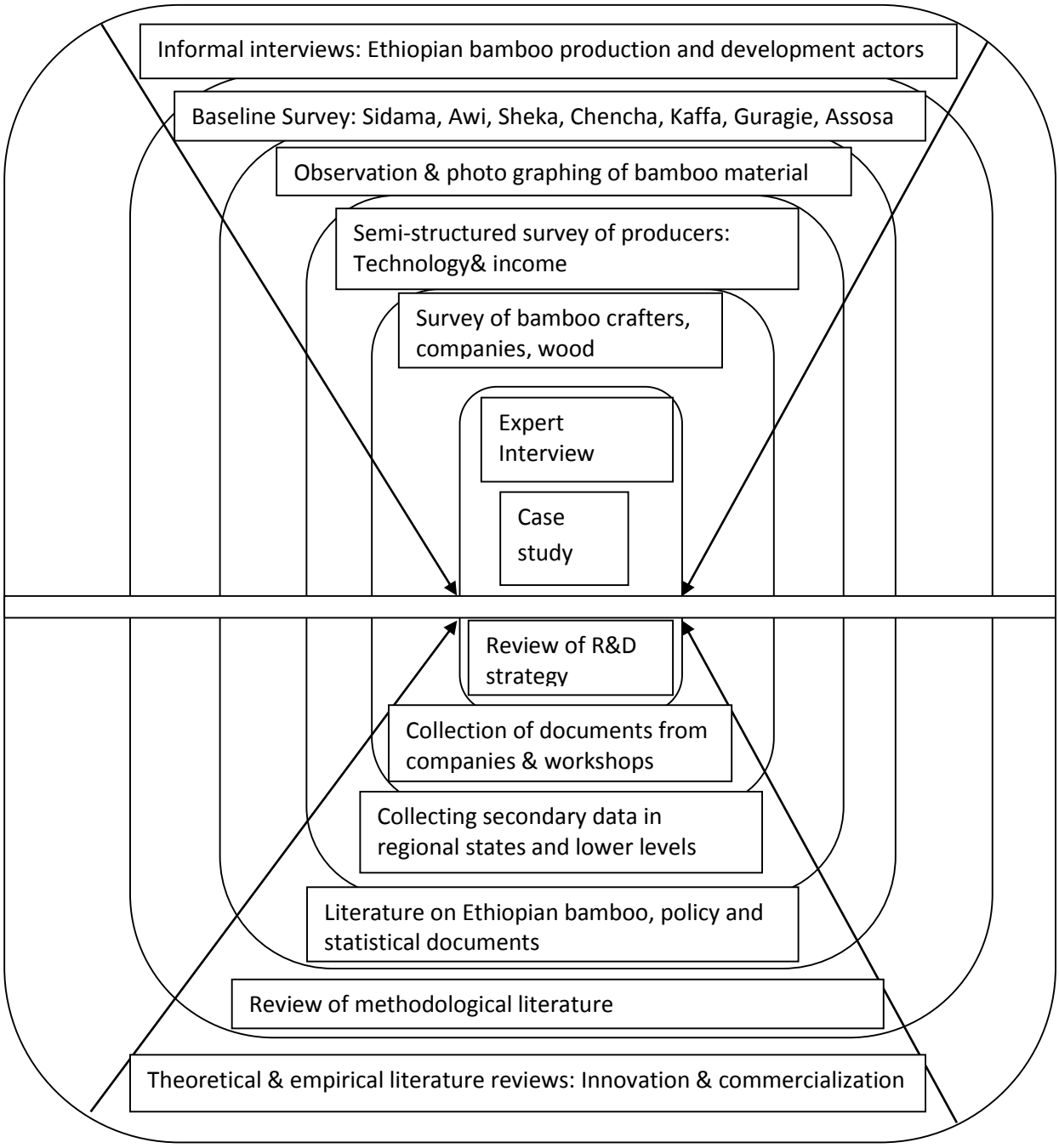


Figure 3.2: The procedures and genesis of primary and secondary data collection.

Table 3.3: Data sources, number and selection of respondents.

Data Sources	Method of sample selection	Number of interviews & remark
Surveys		
Bamboo producer farmers	Systematic random	133
Traders	purposive	3
Enterprises	Purposive	37
Bamboo recreation house owners	purposive	8, as consumers
Bamboo consumers	purposive	30
Bamboo experts & decision makers	purposive	26
Group discussions		
Farmer groups	Purposive	6, two at each district
SME	Purposive	3, one at each city
Case studies		
Craft enterprises	Purposive	2, based on expertise
Adal enterprise	Purposive	1,the pioneer medium enterprise
Aregash lodge	Purposive	Pioneer bamboo tourist lodge

3.4.5 Interview techniques and questionnaire preparation

Interviews can be used to collect data for a range of research types from a mere exploratory study to one which infers causal relationships (Patton 2002; Gray 2009; Flick 2014). According to Cohen et al. (2007), interviews can be a means of gathering information about a person's knowledge, values, preferences and attitudes as well as to identify variables and test their relationships. Interviews are also essential to articulate tacit perceptions, feelings and understandings (Arksey and Knight 1999). Interviews are preferred to other methods when: (i) questionnaires are open ended and complex; (ii) there is a need for highly individualized data; (iii) probing is required (iv) return rate of interviews important; and (v) respondents have difficulty in written language (Gray 2004, pp 214-215). Most of the criteria suggested by Gray (2004) are in agreement with the research setting of this study and hence, his suggestions were followed.

The interview questions were constructed by further breaking the operational research questions into smaller units. Moreover, issues emerged from an exhaustive review of related empirical literature and the researchers' prior experiences in the topic and the study areas were also used as a starting idea in the construction of interview questions. The key concepts analyzed in the theoretical reviews about bamboo

production systems, trade and grass roots innovations were used as a guide to divide the questionnaires using systematic grouping and creating logical order. It was further enriched by conducting test interviews.

For all survey types, carefully worded interview questions were prepared in English. The interview questions were then arranged in such a way that they follow a natural flow of discussion, and as far as possible any potentially sensitive questions including those about income and cattle ownership were purposefully taken towards the end of the interview (Oppenheim 1992). They were translated into Amharic for easy understanding without losing the original meaning. The interview questionnaires were also checked by experienced researchers. All in-depth interviews were conducted by the author.

Before interviews started, interviewees were informed about the research issue and purpose and that the research is not associated with any interest group (neutrality established). Interviewees were able to choose date, time and appropriate location for the interview as suggested by Carson et al. (2001). Moreover, it was also explained to all interviewees that it is for research purpose.

Interviews, especially with bamboo producers and craft enterprises were conducted with prior consent and individually arranged appointments. Appointments were made usually through the development agent or field assistants while the researcher is conducting interviews with other farmers. Every respondent is visited as planned. Normally four to six household interviews are planned for one day. Some of them are not met in the first day despite prior appointments due to their multiple obligations and a necessity to prioritize their other tasks. In this situation, to meet the absentee head/interviewee- another appointment is usually scheduled in the same day. Information about the new schedule is sent to the absentee through the most reliable person, usually spouses or elder children or villagers. Most interviewees approached in this way are available in the next day and the process is continued.

3.5 Data Collection

The major method of data collection for this thesis is the application of surveys. However, the types of survey vary from semi-structured interview with questionnaires to informal interviews and group discussions with open ended interview guidelines. The major surveys conducted for the study and the reasons why they are chosen is also briefly explained.

3.5.1 Preliminary Discussion with Authorities and Baseline Survey

The field data collection began with contacting bamboo field experts and authorities by introducing the study topic and the purpose of the study. The discussion with the respective authorities has two objectives.

The first is to gain their formal approval of the study to be conducted in their constituency which is essential to reduce interviewees' suspicion (Freudenthal and Narrowe 1991; Chambers 1994). This step has been followed from Federal to the district and Kebele levels. The second objective is to have appointment with some of them to discuss about bamboo related practices that they are conducting and their views of the current and prospective development approaches for bamboo. Despite informal discussion continuously conducted virtually with all the authorities, formal expert interviews are made at regional and federal levels. This is because those at lower level of administration largely implement policy directives issued at federal level and regional levels. However, practical grass-root situations and over all community-state interaction with respect to bamboo knowledge and utilization are collected from village officials and development agents. Moreover, their experience of bamboo utilization and the contributions or supports rendered for its development in their respective constituency are discussed.

Once consent is obtained, general reconnaissance surveys were conducted in all the study areas traveling from one district to the other sequentially. The baseline surveys cover most of the bamboo growing districts of Ethiopia: Awi, Beneshangul-Gumuz, Sheka, Keffa, Chencha, Silte/Gurage, Sidama, Bale Mountains and relevant nearby cities. This survey was conducted primarily with purposely selected informants to have a general understanding of the state of bamboo resource, production, utilization and trade. It also allows understanding of the place of bamboo in relation to other similar products in their economic and cultural utilization patterns within the communities and households of the respective districts. Specific data collected during the baseline survey are general bamboo knowledge, uses of bamboo, preservation techniques, the diversity of bamboo houses, bamboo-made tools and equipments. This type of rapid appraisal provides effective and reasonably accurate information about the production system (Cunningham 2001).

Data was collected via stopovers in purposively selected farm households with the assistance of local guides and in house observation, photography and informal discussion with development agents and direct observation techniques were employed. During in house discussions and observation stops, prior permission is requested for observing the house and any bamboo products in the house, and to get household members' support in explaining products and their use whenever needed. During the stops, the types of house, the design and proportion of bamboo used, bamboo treatments and durability, and the type of bamboo household utensils were documented. Discussions were initiated to obtain sufficient description of the products and conditions in each specific context from family members. While household heads often take the larger share of discussion, spouses and children also expressed their views in support

of the household head especially in listing or describing products. Most discussions were made from a setting where recall rate is higher for the product and issue. For this purpose, discussions were conducted inside houses where many of the bamboo uses and items are better recalled instead of in a detached setting. Photographs of important bamboo items were also taken.

Moreover, observations of the general bamboo land use system and local markets were made in most of the bamboo growing areas. The location of bamboo lots in the general land use, utilization and management practices were also observed. In the local markets, observation was focused on visualizing the type of bamboo and bamboo products found. A few informal discussions about the market and the origins and producers of the bamboo products were also recorded. Data from these surveys is important to gain a wide range of exploratory information and to provide framework for subsequent in-depth interviews and case studies. After these surveys, the type of detailed surveys to be conducted at various parts of the value chain and key data required is clearly determined. Then, different types of interview questionnaires were prepared for bamboo producers (owners), bamboo processors (crafters and medium enterprises), consumers (processed craft consumer), recreation house owners (constructors), bamboo experts and decision makers.

3.5.2 In-depth Interviews

Interview based surveys were conducted with bamboo producers, traders, processors and consumers. The focus of each interview and period of survey were described below.

Survey of Bamboo Owners (Producers)

Bamboo resource owners at production areas have several roles in the production- consumption system. They are the managers of the resource, processors of value added products, harvesters and consumers of bamboo and bamboo products. These owners are at the beginning of the bamboo value chain and are the first processors of bamboo into value added products. Therefore, they not only own the raw resource but also the technology and material cultures associated with them. Hence, they are one group of key sources of information for production, market and technology related information required for this study. The major pieces of information collected at this stage of the system were socioeconomic characteristics of the interviewees; household income sources and size; size of bamboo resource and annual volume of sale and household consumption; bamboo price at farm-gate and local market; bamboo management practices including size of labor investment; knowledge of bamboo and bamboo products; types of

bamboo products used; skills in bamboo processing and preservation; tools and equipments used; major customers and patterns of trade relations and etc.

The detailed household surveys, together with group discussions with key informants at the production level, were conducted between December 2011 and February 2012. They were conducted in six *Kebeles*, two in each district. Samples for semi-structured surveys were selected through systematic random sampling by proportional allocation to size of the Kebeles. A total of 133 producer and harvester household heads, among which 38 are from Awi, 43 from Sidama and the remaining from Sheka, were interviewed.

Studies focusing on indigenous knowledge usually apply purposive sampling to select the most knowledgeable individuals in a community and based on them to report the knowledge of the community under study (Alexiades and Sheldon 1996; Tongco 2007; den Biggelaar 1996). Purposive sampling may be useful to know what type of knowledge a certain community owns. However, it does not allow the researcher to know how this knowledge is distributed among the community members. There are knowledge and skills which the largest majority of respondents have and there is also knowledge which is possessed by only a few people. Moreover, traditional knowledge and skills are characterized by secrecy and it is difficult to assume that a larger part of the members have access to it or its application. It can also exaggerate information about community knowledgablity which may affect interventions planned based on this type of study. On the other hand, random sampling helps both to know extent of community knowledge and to compare and contrast knowledge differences within the communities and between communities. Moreover, it allows statistical analysis, and permits comparable surveys in other regions or countries (Ladio et al. 2007). Therefore, quantitative data from random samples are preferred for this type of study (Creswell 2003).

Survey of Enterprises

Data collection from small entrepreneurs or craftsmen residing in Addis Ababa and Hawassa has been made several times. A brief exploratory survey was made in 2010 for the purpose of proposal development. A second encounter took place in December, 2011 while collecting test questionnaires. The final and detailed interviews were conducted between August and October 2012. Although the number of samples is small, it takes quite substantial time and repeated visits to gain reliable data. It is reported that studying enterprises, particularly small enterprises is often more difficult than large enterprises since they lack clear structure and recording procedure (Kirby 2007).

The interviews were made with purposively selected respondents (Miles et al. 2014). This is because: (i) the number of bamboo enterprises are not clearly known. One study shows that they are about 150 (Teketay et al. 2010), while other study estimates them at around 500 (Tadesse 2006) and a baseline survey for this research shows an even lower figure than both studies; (ii) The enterprises entering into the business and leaving the business are not clearly understood and recorded. This is because most enterprises are of the informal, survival type, usually initiated by rural-urban immigrants who leave the business if they find other employment or another source of income; (iii) enterprises carry out bamboo business together with wood, embroidery and other business. Therefore, this poses the problem of whether to choose them as a bamboo enterprise; and (iv) this strategy is in line with the recommendation of Achtenhagen et al. (2010) who argue that purposive sampling is suitable for studies focusing on specific types of firms.

Generally, the number of bamboo enterprises is very small in Ethiopia and total census may not be difficult from the perspective of time and resources. The challenge is, however, how to get their consent. Some of the craft workers are not willing to be interviewed. The reasons reported were that many surveys and development promises have been made, but none of those promises have been fulfilled on the ground. Others of them express their unwillingness without blaming prior experience but by declaring that they are busy, while others request payment.

Enterprises of different sizes and characteristics are found. For data collection, they are broadly classified into medium and small enterprises. Most of the enterprise based analysis is based on this latter group of enterprises. The total number of semi-modern bamboo processing enterprises interviewed is 23. Thirteen of them are from Addis Ababa and five each from Hawassa and Bahir Dar area. Similarly a total of nine traditional enterprises were interviewed: five from Bahir-dar area and four from Addis Ababa. The enterprises working as formal or informal clusters are merged as one enterprise and the leader or the elder member of the enterprise is interviewed. Moreover, one semi-modern enterprise is interviewed from Masha. Since the enterprise is parastatal type and its duration in the business is short, it is not included in quantitative analysis of the enterprises.

There are three private medium enterprises: one pioneer and still producing, the second enterprise has started production, and the third enterprise has not yet started production, they are generally doing pretesting of potential bamboo products. There is one bamboo product producing state enterprise and its manager has been interviewed.

Interviews were conducted by the author through in person contact following the same procedure applied for producer surveys described above and using semi-structured interview questionnaires. The main focuses of these interviews were to understand the general demographic and socioeconomic characteristics, income and performance of the enterprises, sources of technology and information, innovation (practices, types and intensity), types of products produced and means of production, demand and supply condition for bamboo products, institutional/policy environment, pattern of interaction among enterprise (competition and cooperation). The owner and/or manager of respective firms are interviewed.

There are a few traders, usually doing bamboo business part-time or in combination with other products trade. They are interviewed and their responses are used in the analysis of value chain relationships.

Survey of Consumers

In order to have a general understanding of the level of product awareness, demand for quality and future prospect from consumer perspective, an open ended interview is conducted with 8 recreational house owners and 30 craft and furniture consumers. Recreational house owners are selected based on their locational representation and extent of bamboo use for house construction or furniture. Four are selected from regional recreational centers south of Addis Ababa and another four from Addis Ababa and its vicinities.

Samples for furniture consumers are selected purposively from those encountered in bamboo selling areas (initially it was planned to take samples from the client list of the bamboo enterprises). However, the enterprises are not willing to give their contacts. Samples are taken from Addis Ababa (20), Bahir Dar (5) and Hawassa (5). Due to time and resource reasons, the number of samples taken is not large enough to represent the consumer population. It is used only to have a general qualitative understanding of the impression of consumers. However, the samples of recreational house owners are large enough to represent the entire bamboo recreational house owners and hence, this data provides adequate empirical evidence about the perspectives of entrepreneurial consumers.

The major issues covered by consumer interviews are about their familiarity with bamboo products; whether they are using bamboo products of any kind; how they rate bamboo product quality and price in relation to alternative products; their willingness to buy in the future; their satisfaction with existing products; their quality and other demand requirements.

3.5.3 Group Discussion with Producers and Craft Enterprises

While random selection of samples has advantages as described above, it may exclude knowledgeable individuals in the community. To fill this knowledge gap and understand community level knowledge, group discussions with selected key informants were made. Discussants selected are better educated (traditional, priest or modern), have a form of leading role in the community, on average with older age, are knowledgeable about bamboo traditional technologies and utilization culture and manage and process bamboo at least for their family.

Knowledgeable Informants were selected by the consultation of *Kebele* development agents (three people), the chairman and manager of the respective *Kebeles*. However, non-selected individuals also joined discussions. In the discussion, no restrictions were made for the non-invited and no favoritism is given to the selected informants. Facilitation follows the guidelines but give adequate flexibility to discuss issues that are not in the checklist and even at times an issue that is far outside of the study topic. This is tolerated to maintain a healthy discussion environment.

Interview guidelines which include types of bamboo technology in each locality, bamboo knowledge, type of bamboo products, type of uses and extent of local technology applicability by the majority of the community, significance for the community, local technology innovation and its dynamics, and preference of bamboo products over other products and in relation to other competitive resources were prepared and used. The focus group discussions were designed and conducted following the guidelines of (Krueger and Casey 2009).

Similarly, three group discussions were held among the small enterprise owners in the three major study cities. The steps followed for group discussions at producer level were also followed here. The difference is that organizing a group discussion is difficult in the case of enterprises as they are reluctant to discuss the issues and to discuss with their competitors. Discussions took nearly 2 hours each as discussants are very careful to provide their view on the issues raised for discussion. However, they discuss well and freely on problems and challenges they faced. The issues selected for discussion were their innovative performance, technology, tools and equipment, market availability and price, the availability of raw materials, business challenges, institutional supports and other related issues. Notes are taken using a notebook, as they are less comfortable with tape recording.

3.5.4 Expert Interview

Expert interviews were conducted with experts from research and government offices. The experts were bamboo resource managers and researchers, enterprise development and promotion officers, senior decision makers and planning officers with a stake in bamboo development. They were further categorized into two broad categories for planning questionnaires accordingly and ease of analysis of their responses. The categories of expertise are bamboo resource management (raw material development) and processing and policy (those focusing on policy, management, processing technology and value addition practices) (Table 3.4).

Experts are selected based on their knowledge and experience in the topic, their ability to provide solutions for innovation problems and their decision making authority for the sector (Bogner et al. 2009). The interviews were designed in the problem centered interview format (Witzel 2000) by focusing on problems of bamboo commercialization and innovation. Questions were specifically centered on technology sources and upgrading options, capacity building, extent of innovation, incentive mechanism, technology diffusion strategy and challenges, networking and clustering efforts, market creation and bamboo product promotion and challenges and opportunities for bamboo development. In total 26 experts from federal and regional government offices, NGO staffs and researchers/professors were interviewed.

Table 3.4: Interviewed Experts (researcher, decision maker and development agents) working on bamboo resource management and bamboo value added development.

No.	Interviewed expert	institute	Expertise category
1	Head project planning	Ethiopian Ministry of Science and Technology (MOST)	Processing and policy
2	Capacity building head	Ministry of Urban Planning and Construction (MOUDC)	Processing and policy
3	Officer in Investment agency	Ministry of Industry (MOI)	Processing and policy
4	Head of bamboo section	FeMSEDA	Processing and policy
5	Head of training and education	FeMSEDA	Processing and policy
6	Head Sustainable land management (SLM)	SLM	Raw material development
7	Head bamboo unit	SLM	Raw material development
8	Head of natural resource management team	MOARD	Raw material development
9	Expert in bamboo construction	AAU building institute	Processing and policy
10	Graduate student	AAU building institute	Processing and policy
11	Designer and architect	Private expert	Processing and policy
12	Bamboo silviculture expert	INBAR	Raw material development
13	Bamboo management expert	FRC (Forestry Research Center)	both
14	Bamboo management and value addition expert	FRC	both
15	Bamboo utilization expert	FRC	Processing and policy
16	A lecturer	WGC (Wondo Genet College)	both
17	NTFP-Project coordinator	NGO	both
18	Bamboo researcher	Metekel research center	Raw material development
19	Expert in SMEs	Amhara Enterprise agency	Processing and policy
20	Expert in bamboo management	Amhara region	Raw material development
21	Technology development and SME promotion officer	Bureau of Trade and Industry	Processing and policy
22	Expert	African bamboo PLC	Processing and policy
23	Expert in bamboo bioenergy	Bioenergy office	Processing and policy
24	Bamboo development expert	Farm Africa/SOS SAHEL	Raw material development
25	Expert in forest utilization	Oromia forest enterprise	Processing and policy
26	Expert in bamboo technology	African bamboo PLC	Processing and policy

3.5.5 Case Study

Case study as a method is essential to have a holistic and deeper understanding of the why and how of a course of action, process or issue (Yin 2014). A case study is powerful to understand the context in which the action is taking place (Hartley 2004). Therefore, this method supports the other methods for in-depth

understanding of the enterprise environment (Stokes and Perry 2007) in which the various types of bamboo processors are working.

For this thesis, four case studies all at the enterprise level were conducted. The cases are, one small enterprise with specialization in furniture and craft production, another similar enterprise but with more specialization in bamboo based decoration and recreational house building, a third case is a medium enterprise and the fourth case is recreational house owner (a consumer). Case studies were made specifically at enterprise level, since they are the core of innovation and commercialization practices and information access to their internal processing is limited compared to producers.

3.5.6 Secondary Data Collection

This data collection technique is crucial for this study not only as a source of empirical information but also as a source of primary data. It could be an important source of data that at times could not be obtained through interview or observations. Data about training conducted and trainers, bamboo support schemes, policies and development practices in the past and future strategies are obtained largely via published and unpublished documents. It is also an important source of data for analyzing technology transfer experiences, options and challenges.

Therefore, secondary sources relevant to the study theme have been searched, evaluated and used as another source of empirical evidence. Major secondary data used include documents prepared as marketing, technology design and dissemination guidelines; trainee lists and training manuals and consultancy papers on bamboo management and industrialization. Legal documents such as government policies, strategies about bamboo development, rules and regulations are also consulted. Documents are collected from FeMSEDA and its regional branches; offices of Ministries (Agriculture, Urban planning and Construction and Science and Technology), the public library in Addis Ababa and personal sources.

Secondary data from other countries especially from Asia were reviewed. While there is a serious limitation in accessing them for they are largely not in English, attempts were made to analyse those written in English. The focus is genesis of bamboo development, bamboo technology transfer and diffusion techniques, challenges and experience gained.

This method, though important as mentioned, requires precaution especially as a single source of data (May 2011). This is because secondary sources may be loaded with ideological biases and at times could

also be prepared without sound study. Moreover, as Silverman (2006) argues, they may not be a transparent representation of organizational routines or professional dialogues.

3.6 Data Analysis

The diversity of data sets collected through the methods described above, were analyzed to answer the research questions of the thesis. The analysis starts with visualization of the data, particularly the absence of ambiguity, inconsistency, missing values and redundancies. This was carefully conducted before the commencement of the interpretation of the data using various analytical tools. The choice of the analytical method was decided based on the nature of the data at hand and the objectives of the study. Expert consultation was applied before final decision about the analytical methods. The methods of analysis employed were descriptive statistics, regression analysis, ANOVA, Kruskal-wallis test and qualitative case comparisons. Each of these is briefly described below.

Descriptive Data Analysis

The most intensively used method of data analysis for this thesis was descriptive statistics. It was used to understand management practices at production level, income distribution, the extent of bamboo use for producing value added products or frequency of use of bamboo for various products. For instance, the use, knowledge and skill related to bamboo are computed and the result shows the relative importance of bamboo for a certain use. Moreover the number of total uses shows the diversity of the uses of bamboo for communities. This method was also used to analyze the characteristics and performance of enterprises, their technology and innovation types. The analysis was made on Microsoft excel and SPSS version 20. The results of the descriptive statistics are presented as tables, graphs, diagrams and percentages.

Quantitative Inferential Analysis

Determinants of commercialization at various levels were analyzed using best subset regression analysis where the rate of commercialization was taken as the dependent variable. For analysis of differences in income among households and regions, the non-parametric Kruskall-Wallis (One-Way-ANOVAs on ranks) was used due to non-normally distributed data. Normality was checked using the Shapiro-Wilk test.

The comparisons of differences in extent of use, use knowledge, processing skill among households and study districts as well as innovativeness of enterprises were conducted via logistic regression analysis (LRA). Logistic regression analysis type does not necessarily require normality, constant variance and random samples (Hosmer et al. 2013; Coad and Rao 2008). It is also recommended when the explanatory

independent variables are not only nominal or ordinal but also scale variables (Tansey et al. 1996; Peng et al. 2010).

Thus, this method is found useful to capture non-weighted skill related differences and their implications as a source of innovation. It also provides insight into the skill level and its distribution among different age groups. This is important in the sense that farmers follow different decision criteria to use a product they know. Moreover, since most bamboo products require a certain level of skills for processing, their actual use of a product may not only depend on their preference but also their skill to produce their chosen product or their ability to pay for a skilled person if they themselves do not have the required crafting skill. Similarly, Spearman's correlation test is used to analyze relation of knowledge, use and processing skill at production level.

Qualitative Analysis

Secondary data, case studies, group discussions, expert interviews, qualitative interview results from semi-structured questionnaires and a large part of the results from RRA (baseline) surveys were analyzed via qualitative analysis. This analysis involves examining, categorizing, tabulating, summarizing /recombining of qualitative evidences logically using the theoretical proposition employed for the study and descriptive frameworks (Yin 2014). Comparable issues were analyzed by comparing the three rural districts or cities.

4 Traditional Bamboo Knowledge and Utilization Technology

4.1 Introduction

Indigenous knowledge and technology have a vital role in many grass root innovations and are relevant for the development of many rural enterprises (Borthakur and Singh 2012). Although bamboo production and utilization methods in Ethiopia are still rather traditional, it is found that farmers in many areas of the country harbor a diversity of bamboo-based knowledge and processing skills which may provide the basis for wider utilization of the species at industrial scale. This knowledge and technology is often transferred over generations and includes tacit and non-tacit components.

This chapter will provide empirical information about the various forms of bamboo related knowledge, products and process technologies that are still applied in traditional production and utilization systems. The chapter also documents the traditional utility based classification schemes, diversity of use knowledgeand treatment technologies and briefly introduces the various bamboo houses and aspects of the design technologies. The chapter will conclude after highlighting the role of traditional technology for the development of intermediate housing technologies taking the innovation in recreational houses as illustration.

4.2 Traditional Classification of Bamboo Species in Ethiopia

Although there are only two species of bamboo in Ethiopia, informants believe that it has several variants. Overall, 10 different types of bamboo traditional classification methods were identified (Table 4.1). Classifications are mainly based on physical/external features and their preferred applicability for end uses. The major classes include: color which ranges from a minimum of two (red and black) to a maximum of four (red, black, yellow and sugarcane type); degree of pest resistance where some varieties are more susceptible than others irrespective of age; strength, classified as strong and weak where an appropriate utilization scheme is arranged based on their strength; thickness, some varieties have a higher average thickness compared to other types; length of internodes, either long or short, which is useful to decide the workability, aesthetics and breakage condition; age which is classified into young, mature and old and finally it terms of health whether it is alive or dead, pest infected or not.

It is reported that classifications are not mutually exclusive, for example red is associated with weak bamboo stems and susceptibility to pest attack. Moreover, reddish and yellowish bamboos tend to have a longer internodes and attractive aesthetics compared to black bamboo varieties. The color criterion is

used by less experienced buyers to identify the type of bamboo useful for a certain product. Farmers are also interviewed to associate the different classification scheme and the appropriate end uses that a certain variety could be appropriate for (see Table 4.1). Within a certain variety type, for instance reddish bamboo, there are differences in thickness and maturity. The thicker and matured ones are, as expected, preferred and fetch higher prices. Similarly, matured bamboo of a certain class is stronger than younger bamboo of the same class. Thus, a combination of factors is used to determine the quality and usage of culms.

As shown in the Table 4.1, only one of the classification types refers to a taxonomic classification of a species. The rest of the classes are mainly dealing with use-based classifications. In this system, red and black bamboo types were the most frequently mentioned classes. The red bamboo is reported to be generally less strong, have a wider hollow and a relatively bigger culm size and to grow faster than black bamboo. It is easy for splitting and hence the most preferred type for mats and basketry works. Low quality culms of this type are also used for fencing. The black bamboo is generally perceived by the community as strong, resistant to pests and durable. This is the most preferred for the construction of furniture (chairs, stools, tables, shelves) and construction of houses or related purposes. Farmers however do not show a tendency to replace one type of plantation with the other. They do get buyers for both types of bamboo species, a condition that may be essential to perpetuate the two varieties. There is no scientific evidence as to whether the two species are similar genetically or not. Phenotypically one can differentiate the two species visually. Age is also found as another utility based classification. Farmers are aware of the importance of delaying harvest until it matures and know that juveniles though big when seen are not suitable for processing and are not durable.

Differences in classification systems are also noted between regions. In Awi, classification is mainly by colour, only two types; the black and reddish bamboo, and to an extent by thickness. In Sidama, a number of classification methods are reported though the majority of practical classes are based on thickness. In Sheka, bamboo culms are quite similar phenotypically and hence classification is grossly made by size, age and bamboo health. The Chencha communities classify bamboo into four major classes: red, black, yellow and sugarcane types, and bamboo owners classify it into three distinct types only (black, red and sugarcane type).

Table 4.1: Utility based vernacular bamboo classification and description of classes (n=133).

Classification Criteria	Description
Colour	Black, Reddish, Yellowish, sugarcane types
Durability and pest resistance	Often durability is associated with pest resistance. Bamboo which has better pest resistance generally serves longer and is preferred
Strength	Strong species are often used as a basic stand in furniture and in house construction; weak species are often used in split form or as a filling without splitting
Culm thickness	Thick culms preferred for most purposes rather than thin ones.
Length of internodes	Varieties have long or short internodes. Culms with longer internodes are preferred for various purposes. The node is a point of breakage, reduces aesthetic value of the bamboo and increases effort in the design for various purposes
Age	Juveniles (up to 1 year), mature (2-6 years) or old stages (more than six years and when colonized by ferns, other parasites and epiphytic plants).
Health	Bamboo health expressed as deformed, dried, dead, pest infected-usually with holes or rotten surfaces
Growing area	Sidama type, Guragie type, Awi type
Ecology	Highland (Yushinia alpina and lowland bamboo (Oxytenanthera abyssinica), both species found only in Awi
Height	The length of the culm (also considered in the price negotiation)

Source: Group discussion and household interview with bamboo farmers.

There are also household level differences in classification of bamboo. In Awi about 82% of respondents classify bamboo into color classes mainly into red and black. Among them about 87% believe there are differences in strength and subsequent uses. The remainder does not see that there is difference in strength and use of the bamboo. In Sidama, only 38% of respondents report differences among bamboos in their region. Out of these respondents, 23% believe it is due to the inherent nature of the bamboo, 64% due to maturity and the remaining due to other factors such as management or tending arrangement, disease/pest infection, deformation or cattle damage.

Bamboo quality and subsequently prices are determined using traditional grading systems. Grading is largely based on the color of the stem which indicates maturity and the thickness of the stem which determines the use value for various purposes, and size which obviously determines the volume of bamboo culm.

4.3 Traditional Uses and Use Knowledge of Bamboo

Traditional knowledge of bamboo utilization is divided into three types: knowledge of use[6], actual use (application) and processing skill[7] to produce a certain bamboo value added product. This division was made following previous studies on plant use which report that there could be differences in knowledge of use and skills of application (Joyal 1996; Ladio and Lozada 2004; Ladio et al. 2007; Reyes-García et al. 2007).

It is found that informants know a total of 22 different uses of bamboo. These uses are categorized into seven more or less homogenous groups largely following the categorization of bamboo uses made by group discussants in the three sites (see Figure 4.2). Retaining house construction, fuel, food/feed and fence as they are listed, the rest of the uses mentioned by informants have been grouped into three categories ("furniture", "mats and basketry" and "miscellaneous utensils and crafts"). The most frequently mentioned furniture products are chairs, beds and shelves while the most common mats and basketry products are *satara* used mainly for flooring, partition or wall protection from rain abrasion, granary, general utility baskets. The major products in the utensils and craft category include: beehives, enset processing tools, cotton spinning tools, unsplited drinking cups/water containers and umbrellas.

Figure 4.1, shows the pattern of knowledge, use and skill for the various product categories in the three study districts. In general, informants know more uses than they are actually using and have a lower level of skill than they actually use and know. The average numbers of uses mentioned by informants from all regions is four and ranges from two to ten different uses. Therefore, an average individual knows about 18% of all known uses. This may imply that there is no homogeneity of uses and low level of local interaction and knowledge sharing among individuals and regions. On average, informants are using bamboo for 2.4 different uses, of which only 0.47 of the products are produced by an average informant. This implies that there are products which bamboo farmers are using which are not produced by themselves.

While there is no major difference in number of product uses that informants know and apply among the three study districts, there is a major difference in terms of the number of different type of products the

[6] Knowledge of use referes to the theoretical understanding and awareness of different uses of bamboo.
[7] Processing skill refers to the prociciencies and capability developed through experience, training and education to independetely produce a bamboo product applying knowledge of processing steps and tacit abilities.

informants themselves can produce, ranging from 0.11 in Sheka to 0.63 in Sidama and 0.76 in Awi. Therefore, skill is concentrated into a few informants who produce the products for local people largely within family relationships or for non-monetary payments. Except for house construction, Sheka informants virtually use bamboo for utilities without any processing or value addition. Moreover, the skill and engagement in value addition seems to be correlated with the commercialization rate of bamboo in the respective regions. This implies that in areas where there is higher commercial value for bamboo, farmers tend to produce more value added products than in less commercialized regions. The study further reveals that while 65% of the informants know the use of bamboo for furniture, only 14 percent of them reported that they can produce at least one type of furniture. Similarly, while 95% of informants know the use of bamboo for house construction and about 50% of them are using it to construct all or part of their house, only 8% of them are able to produce bamboo house by themselves. The use of bamboo for food is mentioned by only a few respondents (2%) and it is not anymore in actual use in the study areas. Therefore, no one has the skill among the informants to make bamboo edible dishes.

There are also differences in use and skill distribution among regions. In Sheka bamboo is used for fence (94%), house construction (61%) and fuel (27%) of interviewed households. They do not use or know mats and basketry and only an insignificant number of informants mentioned it as useful for furniture. There is one informant who uses it for traditional shelf. In Sidama, bamboo is mostly used for fencing (58%), house construction (48%) and mats and basketry (46%). The Awi communities sell most of their bamboo resource and the remaining is mainly used for mats and basketry, furniture and partially use for house construction (40%). The use of bamboo for house construction may be misleading due to the variation in extent of use. Bamboos constitute only less than 20% of all the raw materials used in Awi compared to nearly 100% in Sidama and about a third of house materials in Sheka.

Therefore, the figure may show the level of use but does not depict the intensity or volume of bamboo use. Similar arguments can be deduced for the skill of house construction where only 7% of the Sidamas have bamboo house construction skills compared to 11% and 8% in Awi and Sheka. The Sidama house, which is made from small splits, seems to require meticulous preparation and design skill (see the description of the various houses in section 4.5.1).

A higher number of house building skills are reported in places where bamboo-house construction requires less design skill. Except house construction where artisans are paid in cash or in-kind, no payments are given for product processing by their neighbors. With the exception of Awi where about 5% of the respondents and 3% in Sidama where products especially furniture and satara are taken to the

market, bamboo products are produced either for the producers' own use or to be given to family and friends.

Further differences in bamboo use and use frequencies are also noted between regions. It is reported that unlike in Sheka, bamboo food is not mentioned in Awi and Sidama. Similarly, no respondent mentions bamboo for construction of bee-hives in Sidama. All regions use bamboo at least for house construction, fence and household utensils. However, its use for fencing is limited in Awi and furniture in Sidama. The use of bamboo for house construction is high in Sidama and Sheka while it is so for furniture in Awi (Figure 4.2). These differences could be attributed to cultural differences among regions since the regions are settled by varying cultural groups.

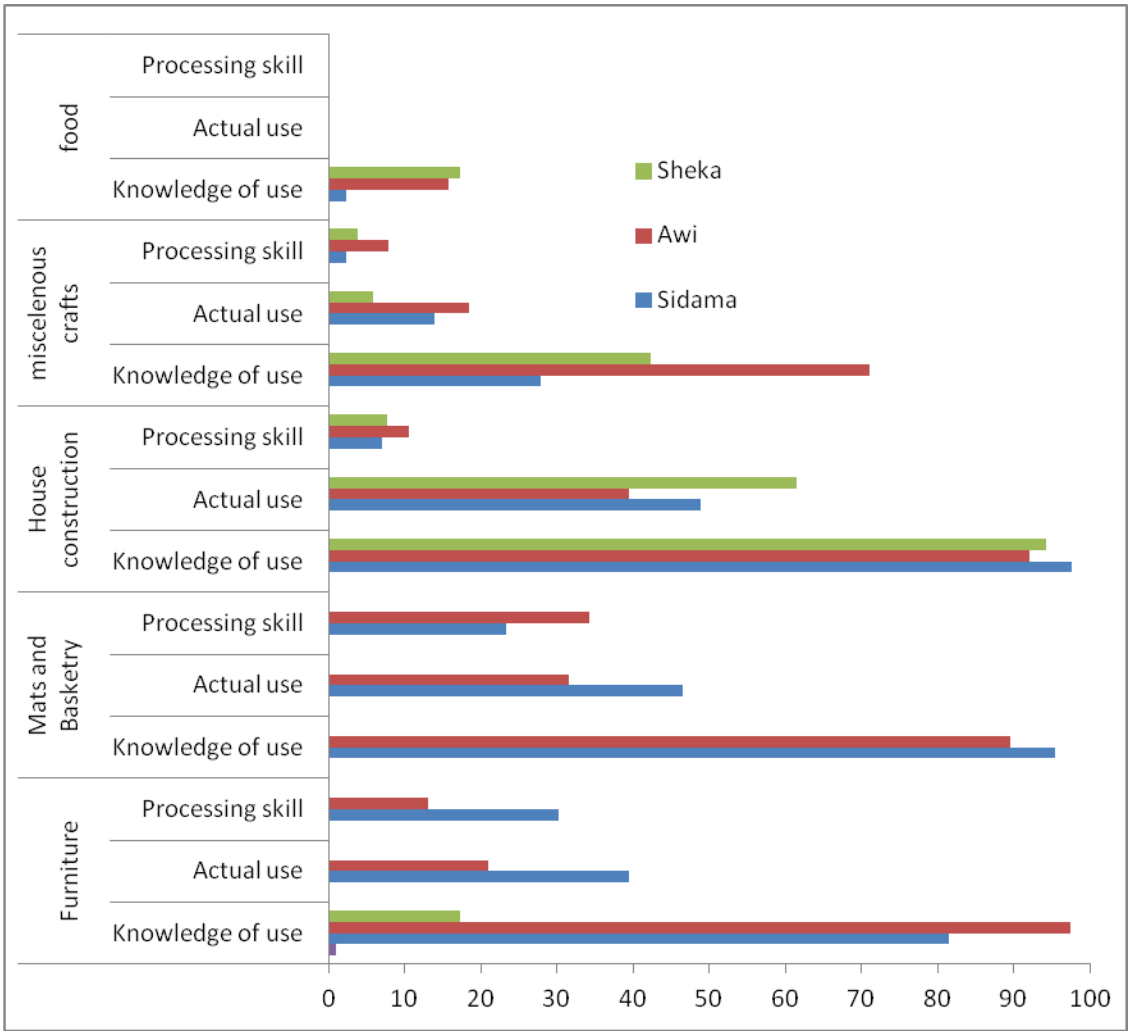


Figure 4.1: Percent of respondents who knows the different used of bamboo, is actually using and have developed the skill to process various products.

Asked if bamboo has any competitive role compared to wood, 35% in Sidama ranked bamboo as first for house construction, while 52% in Awi considers it as the second useful roof construction material. In Sheka, bamboo is ranked as the best useful roof construction material by 28% of the informants. It is not one of the best materials for any of their other household uses in Sheka and its locality.

In order to understand how local opinion leaders valued the various products from economic and cultural points of view, six group discussions were made to list the major uses of bamboo and rank them on a likert-scale in five levels. Before ranking, discussants are first requested to list all uses and group them into homogenous categories. Then they are asked to take five most frequently mentioned uses. Accordingly, fuel, furniture, house construction and fencing are mentioned by all districts as most frequent uses. However, mats and basketry are selected in Awi and Sidama while hive construction in Sheka only. The results show that house construction is a number one priority for Sidama, fencing for Sheka and mats and basketry for Awi informants (Figure 4.2). Similarly, furniture is valued as the second most important product in Awi and house construction in Sheka. The least rated product categories are mats and basketry in Sheka and hive construction in Awi and Sidama. The averages of respondents' ranking of bamboo uses show that house construction (4), fence (3.3) and mats and basketry (3) are the three most important uses of bamboo across the study districts. It reveals that bamboo is still valued for its traditional uses of construction and crafts.

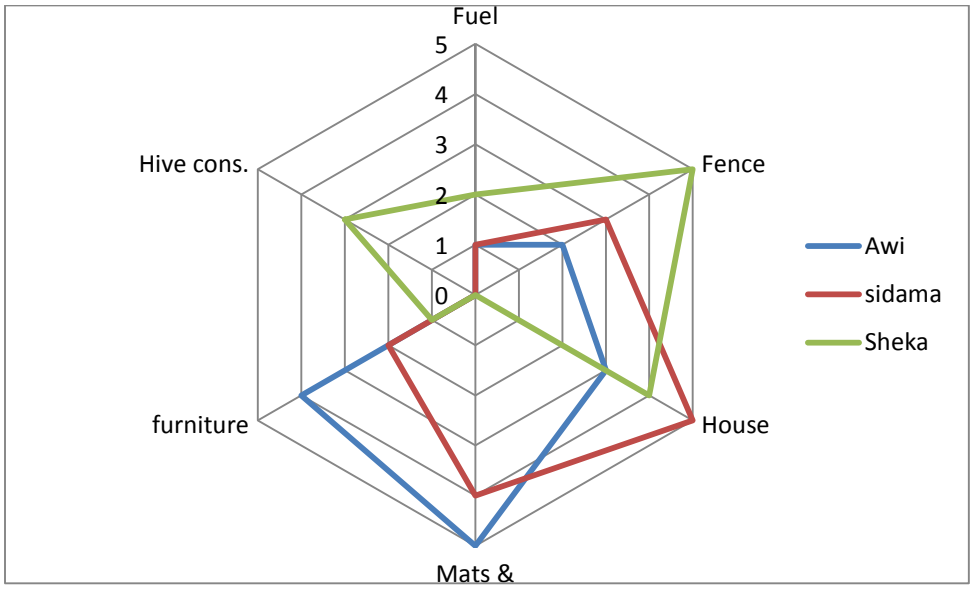


Figure 4.2: The most frequently mentioned bamboo uses on Likert-scale by group discussion respondents from Sidama, Awi, and Sheka (n=6).

4.4 Bamboo Treatment Knowledge and Technology

The major bamboo durability improvement and treatment methods commonly practiced are selection of appropriate harvest season, drying, smoking/fumigation, proper piling, and harvesting when matured (Table 4.2).

It is revealed that the months between September and December are the appropriate harvest season to obtain durable culms. Scheduling harvest during this period reduces vulnerability of harvested culms from pest infestation. The reason mentioned is dry conditions are not conducive for pests. Techniques such as sun drying and wet treatment and harvesting during dry season are practiced to reduce pest palatable contents of the culm. On the other hand, smoking is used to create a hostile environment for pests. Moreover, depending on the species used for smoking or fumigation, it can also kill insects (Box 4.1).

Group discussants have confirmed that though drying is done before use, the degree of drying varies from person to person and according to the nature of the end use for which the bamboo is intended. Moreover, it is reported that drying intensity for weaving products such as mats, baskets and Sidama houses is relatively lower than for other house constructions and non-woven furniture. The reasons were that highly dried culms are too brittle for weaving practices. They rather dry after the weaving is completed. On the other hand, it is also reported that the use of improperly and poorly dried culms results in susceptibility of end products, such as: leaned houses, furniture shrinkages and loose connections at the edges.

Table 4.2: Treatment methods applied traditionally in the three study regions (n=133).

Methods of treatment	Frequency of application		
	Sidama	Awi	Sheka
Appropriate choice of harvest season	6	3	16
Selection of quality variety (resistant, strong)	2	0	0
Proper and complete drying	4	4	0
Use matured culms	4	1	0
Smoking	2	0	0
Increase aeration by upright piling	0	1	7
Avoid October and April cut (high pest prevalent season)	0	1	0
Cut in March	0	1	0
Cut after December	0	1	0

Table 4.3: Traditional bamboo preservation methods mentioned by group discussants and their description based on group discussion and household interviews.

Type of knowledge	Description of the Treatments
Season of the year	All respondents believed bamboo has to be cut outside of the rainy season and shooting period
Hours of the day	Discussants believe cutting during the dark and sunset is good to reduce pest attack
Age	All respondents think young bamboo are susceptible to damage and products will be less durable
Drying	Adequate and appropriate drying were mentioned as the major tool to reduce susceptibility
Smoking	Most rural houses are exposed to smoke after construction
Upright Pilling	Discussants mention upright stocking as a technique though they think it is only a few who apply it
Use of wet treatment	Expose to rain so that sugary substances are washed away. A crafter in Chencha uses this technique in river.
Species selection	Black (strong) is preferred for construction and furniture while the red (yellow) splitable varieties are used for weaving and basketry
Species for smoking	Many species but kinchib (*Euphorbia tirucalli*) not only to eliminate the food for insects but also to poison the insects

Box 4.1: The use of *Euphorbia tirucalli* for bamboo treatment.

A respondent from Chencha reports that while all smoke are poisonous for pests that attack bamboo, the use of kinchib (*Euphorbia tirucalli*) smoke kills all microbes and avoid smells. It also makes the house free of other biting insects and is most preferred for houses used for recreation and other houses where there is no continuous smoking. Thus, he claims that kinchib (Euphorbia tirucalli) is crucial not only to eliminate the food for insects but also to poison the insects and make environment insect free.

Source: informant interview during baseline survey and group discussion

4.5 Traditional Bamboo Housing and Weaving Technologies

Although there are over 20 different uses of bamboo registered in rural areas of Ethiopia, three product categories are most abundant and require relatively higher level of skills. These product categories are house construction, traditional mats (*Satara*) and various types of furniture products. Therefore, these bamboo based products will be described and the basic knowledge and skill aspects for processing the products are briefly elaborated in the following section.

4.5.1 Diversity of Bamboo House Technology

A great diversity of bamboo house types, which vary in design, construction process, durability and proportion of bamboo raw materials used in the entire house, is identified in the survey areas. Based on the proportion of bamboo use to other materials, bamboo houses of Ethiopia vary from total bamboo to semi-bamboo houses and to those where bamboo has only a supportive role as used in the roofs of wooden houses. Moreover, differences are observed in the level of skill embedded in the community from those which can be constructed by the majority of the community members to those only made by skilled artisans who lead the design and construction process- a condition where knowledge and skill is concentrated only in a few artisans. Similarities are also noted, especially their preference of bamboo for roofing material and in the nature and source of knowledge transfer. For ease of analysis, designs are made based on the name of the cultural groups of the regions to which the houses are most common. Overlaps are, however, conspicuous. For instance, Kaffa and Sheka types as well as Gumuz and Awi types have a number of common characteristics and are described in the same sub-sections. Major bamboo houses found in Ethiopia includes: the Sidama, Awi, Chencha, Sheka, Kaffa and Gumuz types. Separate description is given for these major housing types followed by a comparative summary.

Traditional Dorze House

The Chencha people commonly called “Dorze” are skilled in weaving of cloths and construction of bee-hive shaped bamboo houses, the latter of which has also a major weaving components. According to informants houses are built with strong variety that includes black bamboo: thin in diameter, matured and properly dried bamboo sticks and poles. They are constructed as a whole set of a single structure where there is no distinction between roof and wall. Whenever a bamboo stick/pole fails to reach the top of the house, another stick is added and continues all the way till the roof top. It is whole set of a single structure. The informants and discussants said that unless improper thatching lead to early fragility of the houses, properly constructed and thatched bamboo houses can last between 50 and 60 years, where 40-50 years is reported as the average age. Only changing the thatching is required. When the foundation part may be affected by termites, informants report that the entire house is lowered after digging around the base and allowing it to drop a number of centimeters equivalent to the length of the damaged part. Apart from selecting and constructing houses carefully, the local informants believe that the natural treatment with smoke makes the structure remains strong and resistant to pest attack.

Figure 4.3: Dorze houses-predominantly made from bamboo

Traditional Sidama house

The bamboo houses of Sidama are made from matured bamboo culms after being split into smaller pieces and plaited together to form a dome shaped structure with pointy top to facilitate rainfall exclusion. The roofs are two layered where the inner space in between the layers is filled with bamboo sheaths to create a water proof structure. The outer woven cover will protect the sheathed layer from rainfall and sunshine related wear and tear. In Sidama houses, bamboo constitutes the entire construction material except ropes made from *Enset* to tie important joints. The house construction is more or less similar to Chencha in its design. However, unlike the Chencha, the Sidama house is built on bamboo upright structures instead of wood. Moreover, the Sidama is dome-shaped while the Chencha more cylindrical. Despite important skill harbored in their housing culture, most of the survey respondents and the group discussants believe that knowledge and skill are fast depleting. Reported reasons are the children are not learning traditional skills and an increasing cultural change from bamboo houses to wood houses which are easier to construct.

Figure 4.4: Sidama houses (A) and bamboo leaves for thatching (B)

Kaffa/Sheka Bamboo Houses

In Kaffa (Manjewo area), bamboo is used as a component in the majority of houses. They use it for walls, roofing, thatching, tying and so on. However, as in the other regions, bamboo is predominantly used in the roof. Like in Sidama, bamboo sheaths are used for roof thatching but in combination with grass. The outside part of the thatching is covered with grass while the inner part remained bamboo sheath. Walls are predominantly made from hardwood. Bamboo has a minor role in wall construction. Even within this region, depending on their proximity to bamboo, farmers construct predominantly bamboo houses while others make hardwood dominant houses. Similarly, in Sheka, roofs are almost entirely made from bamboo. Walls are largely made from indigenous wood where bamboo has a supportive role. The house design is rectangular with two supporting beams. This house designs are relatively complex and hence constructed with the help of a knowledgeable local carpenter/artisan.

Figure 4.5: Kaffa (A) and Sheka (B) houses and old ceiling (C)

Guragie/Siltie Bamboo Houses

Bamboo houses in Guragie/Silte areas constructed using half split bamboo for walls and unsplitted culms for roofing. In the wall, they largely use wood. The discussants reported that the role of bamboo is to serve as a horizontal strengthening structure for the upright wood, to improve the aesthetic features of the wall. On the other hand, bamboo is a major raw material for constructing roofs and only a few other materials may be used to supplement the bamboo in roof structures. Thus, the use of bamboo is largely as a major

product in the roof and supportive and decorative purposes for walls. They also use bamboo to construct doors and partitions inside the house.

Figure 4.6: a typical traditional Guragie/Silie Houses where roofs and walls are made mainly from bamboo.

Bertha/Gumuz and Awi Houses

The Berta houses of this region is particularly studied and is reported that bamboo is their most useful woodland species with several uses compared to other species growing in their region. According to the informants, it is widely used for house construction. It is reported that bamboo is the single most important raw material for roof construction, while thatching is made by high quality low land grasses. Moreover, due to the fact that the culm is strong, solid and heavy in weight, it replaces wood for door construction. Although lowland bamboos are believed to be inherently durable, houses are small in size and durability is lower than in all the other bamboo houses studied in Ethiopia. One of the reasons reported is severe termite attack which is attributed to the warm climate of the region. The other reason reported is low attention given to durability during construction. Informants also reported that few treatment methods are used before and after construction.

In Awi, bamboo is a scarce resource; and hence used for most economically attractive uses only. Bamboo is occasionally used as a mixture in the roof. The house design is more or less similar to the Bertha type. However, they have longer wall and are furnished with mud, often bigger in size, durable and the basement is strengthened with stones.

Figure 4.7: A circular Bertha Tukul made from bamboo, hardwood and dryland grass. The tukul is vulnerable to termite attach and have the shortest durability of all house types.

Similarity and Differences in the Technical Design and Use of Bamboo Houses

As described above, there are a number of similarities and differences among the traditional houses. Key features in terms of the number of knowledgeable household members, the extent of bamboo use, durability, shape and design features are presented in (Table 4.4). It is found that bamboo is used to construct the entire house in Sidama while it is a minor component in Awi houses. Among all the study houses, the Dorze house is reported as the most durable, probably due to a combined effect of the use of the strongest black variety, various supporting woods, proper treatment of the culms and colder climatic conditions. The least durable is the Bertha/Gumuz house mainly due to strong termite attacks, and its location in a warm climate suitable for many pests.

The study further reveals that regions which used to use bamboo for house construction have now shifted to other construction materials. For instance, informants report that in central Sidama (Dale area), bamboo was an important house building material just half a century ago and now few bamboo houses are found in this district. This may be due to the fact that knowledge is not transferred to the next generation in the region, or people have shifted in to other contexts (e.g. urban construction or tourist houses). The second reason reported was increasing competition and increased prices for bamboo, especially bamboo sheath which is no longer affordable for farmers and without which they think it is difficult to construct a Sidama house.

Table 4.4: Summary of major traditional bamboo housing types of Ethiopia & characteristic indicators (Source: Baseline survey and group discussion)

Selected indicators	Sidama	Chencha	Kaffa/Sheka	Bertha/Gumuz	Awi	Guragie/Siltie
Extent of bamboo use	Entire House	Bamboo majority	Roof bamboo majority, wall partially	Bamboo majority in wall and roof	Bamboo used in the roof	Roofs mainly, wall partially bamboo
Shape	Dome shaped	Dome, "hive shaped"	Circular, separate roof and Wall	Circular, small and short	Similar to Kaffa type	In between dome and circular houses
Diversity of skilled artisan	A few per district	One per *Kebele*	One per village	Majority of them can build their house	Most elders know the design and construction	Carpenter/artisan 1-2 per *kebele*
Durability*	20-30	40-50	10-20	1-10	15-20	20-30
Roof thatching	Bamboo sheath	Enset leave, grass and Bamboo sheath	Bamboo Sheath and grass	Grass	Grass	Grass

*In all houses, except Bertha/Gumuz, roofing cover will get old before others and often replaced in 5-10 years and its earlier replacement is an important requirement for bamboo house to serve longer.

4.5.2 Bamboo Mat and Basketry Technology

Next to house construction and in places fences, mats and basket products are reported as the most common uses of bamboo. Mats and baskets are bamboo-woven products made from splitable bamboo varieties by splitting and slicing the culms longitudinally and weaving the splits/planks. The length of splits depends on the size of the planned mat.

Products in the mat category are used as floorings in rural houses, used in burial for rolling dead the body, protection of walls from rain abrasion, partitioning of house to bedroom, salon and other parts. Mats are also used for beds and also as sheets to sleep on the ground. Mats are useful for chair and table parts, shelves and other utensils. In small towns also in Addis Ababa, road side venders use bamboo trays for placing their article of commerce, using the bamboo as a temporary shelf during market exchange. Mats from stronger and matured bamboo, designed and constructed in better quality are used for door construction for houses and also door for fenced houses.

Similarly, products in the basketry category are mainly used for grain storage, cloth containers, waste disposal depot or containers for carrying cow-dung out in the field to use as a fertilizer, containers for taking products to market, umbrellas, or *akimbalo* a cover of *mitad (*a traditional clay used for baking of

injera). In some situations, a cylindrically designed bamboo basket is also used as protection from animal damage for newly planted seedlings, mostly in urban forestry practices.

Variation and aesthetics in mats is often created by diversifying the split size and orientation, mixing of the various local variants of the bamboo and traditional coloration of the splits using different colors. The differentiation and diversification of the split size is one of the most important criteria. It is reported that finely splited, well woven and strongly designed mats preferably with a matured bamboo are the most preferred for the majority of end users. Artisans also improve craft color via artificial dyes.

The selection of bamboo culms for weaving is not only dependent on color but also the length of internodes. The bamboo culms with the longest internode are the most preferred for making bigger mats. Respondents also recognize that long internodes increase workability and reduce the time required in the preparation of slices or strips of bamboo.

The first difference between mats (*satara*) and baskets is the level of skill required for making these products. Basket designs require more skill and control of the structure of the products. The width, length and the whole structural design has to be overseen at each stage of the preparation. Baskets are of different types and gauging the process according to the product design, for instance between fruit trays and granary, requires a higher skill. Several of the baskets used for house utensils require fine and aesthetically attractive designs. Mats are mostly used for low quality products and essentially require no major aesthetic work. Baskets are mainly made by women while mats are made by men.

4.6 Transition to Semi-modern Bamboo Houses and Furnishing

Transitional bamboo houses are constructed mimicking traditional bamboo houses from the countryside. Asked if there is any difference, recreational house owners think that the latter are transformed into modern designs retaining their traditional authenticity and adding features such as concrete supports, chemical treatments and addition of materials that enhance the strength, durability and aesthetics (Annex 10.5 and figure 4.8). They use crafts and traditional utensils in the various parts of the house to enhance attractiveness of the house for their customers (tourists and recreationists). Moreover, it is observed that most of them (63%) also use bamboo mats with a higher quality level as fruit and food services treys. Twenty-five percent of them also reported that they use imported bamboo service trays for sake of quality.

Figure 4.8: Improved traditional house (bamboo 'gojo' and a ceiling made from bamboo & wood beam)

Recreation house owners report that houses are often built taking one or more ethnic houses as their model design. For instance, a tukul of Negash lodge (Southwest Shoa) is an amalgamation of the Sidama and Dorze house design and structure. Moreover, lodges made with bamboo in the rift valley imitate aspects of the traditional house designs of central Oromia region and the Sidama houses. The blending of different traditional houses and modern design feature may facilitate learning among artisans and modern designers. This may be the reason for housing innovations from traditional to transitional observed in the design, quality and durability of the recreational houses (Table 4.5).

Recreational house owners report that both traditional artisans and urban crafters build houses according to preferred design. However, crafting skill to produce furniture is found to be limited and often only urban craftsmen handle the furniture production. This may show that the presence of adequate skill in house construction can facilitate technology transition. On the other hand, the relatively lower levels of craft technologies hinder faster development of the furniture industry. This is in line with theoretical and empirical literature which asserts that the presence of indigenous skill and knowledge accelerates indigenous technology development and also the importing of technologies (Siyanbola 2012; Fu et al. 2011; Mowery and Oxley 1995; Szulanski 1996).

The transformation of this technology could be faster if these traditional technologies are nurtured and technically supported by R&D in an organized and sustainable way. This is illustrated in the case of the technology transformation by the honey networks of India and NTFP standardization and development works of China (Siyanbola 2012; Gupta 2006; Acharya and Shrivastava 2008).

Table 4.5 Comparison of traditional and transitional (improved) bamboo houses

Features	Traditional house	Transitional house
Technology	Traditional tools and equipment Traditional preservation techniques Technicians are local craftsmen	Intermediate technology Traditional and chemical preservatives Mainly traditional craftsmen, but vocational trainees also involved
Design	Indigenous designs, inherited from heirs Diverse types and varies from culture to culture	Maintain the blue print of the traditional design but modified to tourist test, various cultural designs may be blended Introduce aspects of modern design e.g. concrete foundation, low diversity
Purpose	Living house Inspired by resource availability, inherited practice, feasibility and local preferences	Recreational houses, offices, cultural houses Inspired by the quest for the authentic by tourists
Management/ organization of construction	Constructed by traditional people organized in group called "Debo". Often skilled artisan/s artisans lead the design and construction	Technicians are traditional craftsmen and trained designers/constructors, business is overseen by businessmen
Role of bamboo	Varies depending the culture, but can be used from flooring to wall, roof and thatching, often earth basement	Basements are cement, the rest of the roles can vary as the traditional houses, but generally bamboos are predominantly used
Inside decoration	Natural aesthetics and decorations, a few bamboo crafts and furniture	Various forms of decorations used to appease tourists and recreationists, may be furnished with traditional bamboo furniture and crafts

Source: own elaboration from interview of bamboo producers and recreational house owners

4.7 Socioeconomic Factors Affecting Processing Knowledge and Skill

Socioeconomic factors and institutional support schemes provided for informants were checked to measure their impact on bamboo processing skill. The indicators were selected based on literature review. The factors were income, age, education, training and extension support (specifically in relation to bamboo), distance to market, management regime, location, and family size. The result shows that skill is significantly affected by knowledge, bamboo income, management engagement and distance from market access. The more knowledge farmers have about bamboo, the higher their engagement to process bamboo and inturn develop a better skill than those with limited knowledge of use. Therefore, the promotion of knowledge on bamboo significantly contributes to the development of craft skill among the studied communities. Similarly, respondents who invest more time in bamboo management have also a higher propensity to be skilled in bamboo product processing than those who invest little time in bamboo management. Farmers who invest more time on management of bamboo found to have a better

processing skill than those who produced from unmanaged stand. Moreover, regions closer to urban areas where there is an adequate market are more skilled than those residing in remote places. This shows that, though bamboo processing takes place largely for own consumption, knowledge obtained from value chain based interaction might have motivated producers to engage in processing of bamboo and hence develop better skills than those in the remote areas.

Table 4.6: Results of logistic regression on factors affecting skillfulness of farmers in bamboo product processing in the bamboo growing regions of Awi, Sheka and Sidama (R2=0.362, N=133).

Variable	B	df	p-value
Bamboo Income	.000	1	.049*
Market distance	-.003	1	.001**
Management input	.319	1	.019*
Training attendance	.467	1	.408
Education	-.078	1	.419
Age	.006	1	.741
Bamboo knowledge	.728	1	.009*
Family size	-.008	1	.942
Constant	-2.815	1	.099

* significant at 0.05 level

**significant at 0.01 level

On the other hand, training and extension support, basic education level, family size and age do not significantly affect skillfulness of the households (Table 4.6). The fact that training does not bring about a significant difference in craftsmanship skill leads to a need to question the nature of trainings. The reasons could be (i) the quality of trainings, (ii) trainee selection as mentioned earlier and (iii) less interested individuals attending trainings. Therefore, there is a need to improve the training quality, selection of trainees and administration of the training system. Similarly, the fact that level of general education did not produce a significant difference in bamboo processing skill implies that basic education is not a necessary condition to acquire crafting skills.

In order to understand the relation between knowledge of use, actual use and processing skill, Spearman's correlation test was used (Table 4.7). The result shows that processing skill is significantly correlated with knowledge of use at 0.01% and with actual use at 0.05% level (Table 4.7). Similarly, knowledge is significantly correlated with actual use at 0.01%. Thus, knowledge of use may stimulate

skill development and the tendency to use more bamboo products by producing households. Thus, an increased awareness about the diversity of bamboo uses may stimulate commercialization of the resource by increasing local demand for processed products at producer level and may correspondingly increase the number of farmers interested to engage in own craft processing. This result do not corrobrate an earlier study by Kightley et al. (2013), which showed that knowledgeablity and processing skill does not necessarily correlate.

Table 4.7: Spearman's correlation of processing skill, use knowledge and actual use of respondents from Awi, Sheka and Sidama (n=133).

		Processing Skill	Use knowledge	Actual use
Processing skill	Correlation Coefficient	1.000	.248	.179
	Sig. (1-tailed)	.	.002*	.020*
	N	133	133	133
Use knowledge	Correlation Coefficient	.248	1.000	.259
	Sig. (1-tailed)	.002*	.	.001**
	N	133	133	133
Actual use	Correlation Coefficient	.179	.259	1.000
	Sig. (1-tailed)	.020*	.001**	.
	N	133	133	133

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

4.8 Summary

The empirical results presented in this chapter reveal that there is a diversity of bamboo related traditional knowledge and skill ranging from treatment techniques to construction of houses and craft products. It is further highlighted that households with better access to markets and who receive a higher proportion of their income from bamboo and having more knowledge of use are more skilled than those with limited exposure and comparatively lower income and knowledge. On the other hand there is no significant difference in training attendance. This could probably be attributed to low quality of training which could not bring about the expected differences in craft skill. The knowledge and technologies, particularly the housing technologies, are reported as a basis for the development of transitional bamboo recreational houses and associated decoration and furniture. Moreover, as will be presented in the subsequent chapters, this knowledge and technology is also found to be one of the major sources of knowledge for craft processing enterprises in the urban areas.

5 Bamboo Enterprises' Characteristics and Business Performance

5.1 Introduction

In the previous chapter, the knowledge, practices and diversity of traditional bamboo utilization have been presented. Moreover, the trends in the development of bamboo houses from traditional to transitional have been briefly explained. This chapter is a continuation of the bamboo utilization culture from rural to urban and from traditional to transitional and then to semi-modern technologies. The center of analysis in this chapter is bamboo enterprises, mainly the craft enterprises which are the largest and one of the major players in the bamboo sector at this point in time. Craft enterprises are part of the wider SMEs community, but are generally at the lower end of the scale in terms of numbers of people employed and thus are generally referred to as micro-enterprises (McAuley and Clarke 2009).

These enterprises are crucial for sector development via innovation and creativity, market expansion and investment in any sector (McAuley and Clarke 2009; Baliamoune-Lutz 2007). To this end, this chapter will provide empirical insight into the characteristics of bamboo craft enterprises and performance.

5.2 Characteristics and motivation of Bamboo Craft Enterprises

All bamboo craft enterprises (n=32) are solely owned and managed by their owner. Nearly 28% of these enterprises have no additional workers. The average number of employees is 3.5 per craft shop. Nearly a third of all the employees belong to only two craft enterprises. The largest number of employees a craft enterprise reported having is 24. The majority of the craft enterprises have employees ranging between 2 and 5. All traditional enterprises are without additional workers. The number of family employees is lower in Addis Ababa than Hawassa. This could be due to the fact that Addis Ababa is a metropolitan city where business focused employment is more common than in Hawassa, where family ties and responsibilities are more or less intact. Moreover, the number of employees reported in Hawassa is even larger than in Addis Ababa due to the fact that they counted cluster members as employees (Table 5.1). When the cluster members are deducted, actual employees are 2.3. Bamboo craft workers in Bahir Dar employs the smallest number of staff, probably due to the low level of market and more limited capital than, for instance, in Hawassa where there is government support and a flourishing market.

Table 5.1: Employment profile of craft enterprises in three cities disaggregated by nature of employment and family ties (n=32).

Nature of employment	Addis Ababa	Hawassa	Bahir Dar	Average
Temporary	2.9	4	0.5	2.3
Permanent	1.6	1	0.4	1.2
Family workers*	0.4	3.4	0.2	0.81
Total	4.6	5	0.9	3.5

*Family workers are included either in temporary or permanent employment category, and hence is not included in the summation to avoid double count.

Major reasons for joining the bamboo business are low starting capital (56.3%) and a lack of other options (34.4%). About 13% of the respondents said that they had no intention to pursue a bamboo business but were trained to establish bamboo craft shop by NGOs. Nearly 10 percent of respondents think it is a profitable business. Other factors such as "I like the business" (6.3%), "inherited from father" (3.1%) and "to create job for a friend" (3.1%) are also mentioned as a motivation. Motivations are essential for successful business development (Hessels et al. 2008; Eijdenberg and Masurel 2013). The fact that the major reasons to engage in bamboo craftwork is a desire to satisfy immediate livelihood needs in the absence of other alternatives and that they were trained to be craft workers, may adversely affect business sustainability and innovativeness. This result corroborates studies on craft production in South Africa (Rogerson and Sithole 2001; Roy and Wheeler 2006; Chu et al. 2007; Kiggundu 2002) but is in contrast to (Gobagoba and Littrell 2003; Adam and Pettenella 2013) where entrepreneurs are more involved with interest to business than for survival or due to external driver.

Out of the total number of craft enterprises interviewed (32), only one of them was a woman. However, there are a number of women employees mainly engaged in mat and basketry aspects of the craft. Informal discussion with a couple of these employed women showed that their major reason to start their own business is lack of startup fund. In contrast to this, a study on wood furniture in Sudan reports that the fact that women are less involved may be due to lack of carpentry skill (Adam and Pettenella 2013).

The mean age of craft enterprise owner is 29 years and ranges from 18 to 43 years. The mean age is found higher in Addis Ababa (30.5) and lowest in Hawassa (25.2). Bahir Dar is slightly lower than the mean age (28). Craft enterprise owners usually start bamboo business well before or early in the twenties and leave it as they become aged. It is reported that the main reason that older people are not in the business is that it is manual and hardly manageable at an old age. Moreover, it is not a preferred job so long as there is alternative business.

Craft enterprise owners have an average experience of seven years with a range from 1 to 13 years (experience refers to the total years of engagement in bamboo craft work excluding internships. Internship is considered as training). The majority of traditional craft enterprise owners' (those using traditional hand tools) experience is less than five years, while semi-modern enterprises (those using at least semi-automated machines) (Table 5.2) is about 8 years. It is reported that after working for a time, many traditional crafters shift to other livelihoods (including farming, daily labour) or upgrade to semi-modern type or leave the business altogether. Region wise, the number of years of experience of craft enterprise owners in Hawassa is found to be fewer than the average.

Table 5.2: Average experience in years of bamboo craft workers from the three study cities (n=32).

Enterprise type	Addis Ababa	Hawassa	Bahir Dar	Weighted Average
Traditional (n=9)	3.9	-	4.2	4.1
Semi-modern (n=23)	8.9	2.3	8.4	7.5
Weighted average	7.74	2.3	6.3	6.52

All the interviewees but one has attended different levels of education. However, traditional craftsmen have lower average schooling (5.3) than the semi-modern craft workers (9.6 years). The majority of semi-modern workers completed high school (Table 5.3). Intercity differences were found insignificant.

Table 5.3: Educational status of bamboo craft workers disaggregated by enterprise category (n=32).

Education status	Traditional	Semi modern	Total
No Education	1	-	1
1-4	2	-	2
5-8	5	5	10
9-12	1	17	18
Above 12	-	1	1
Total	9	23	32

5.3 Classification of Bamboo Enterprises

Various bamboo enterprise types are identified and described. They can be broadly classified into three based on (i) size: medium and small craft enterprises; (ii) formality: formal and informal (registered or unregistered); and (iii) level of cooperation: as voluntary informal craft association (group work arrangement) or legal association where there are common assets and capital (externally initiated clusters) or spontaneous market induced clusters.

Within the size class, the medium enterprises are small in number and homogeneous and hence no distinct differences are found. However, the small craft enterprises are found to be heterogeneous and reveal several differences. Thus, they are further classified as semi-modern craft enterprises and traditional craft enterprises (Figure 5.1). The semi-modern craft producers are further classified into private, parastatal and hobbyists. The private craft enterprises are large in number and have a smaller number of employees than the hobbyists or parastatal enterprise. Moreover, they largely use labour intensive craft technologies with a few semi-automated hand tools. The hobbyists are mostly expatriates and produce products mainly as a hobby, but they also gain income and employ staff to work on it. The Ethiopian tourist enterprise produces bamboo exclusively for market and is profit oriented. It has the largest number of employees and has relatively modern craft processing machines and has separate workshop and display places.

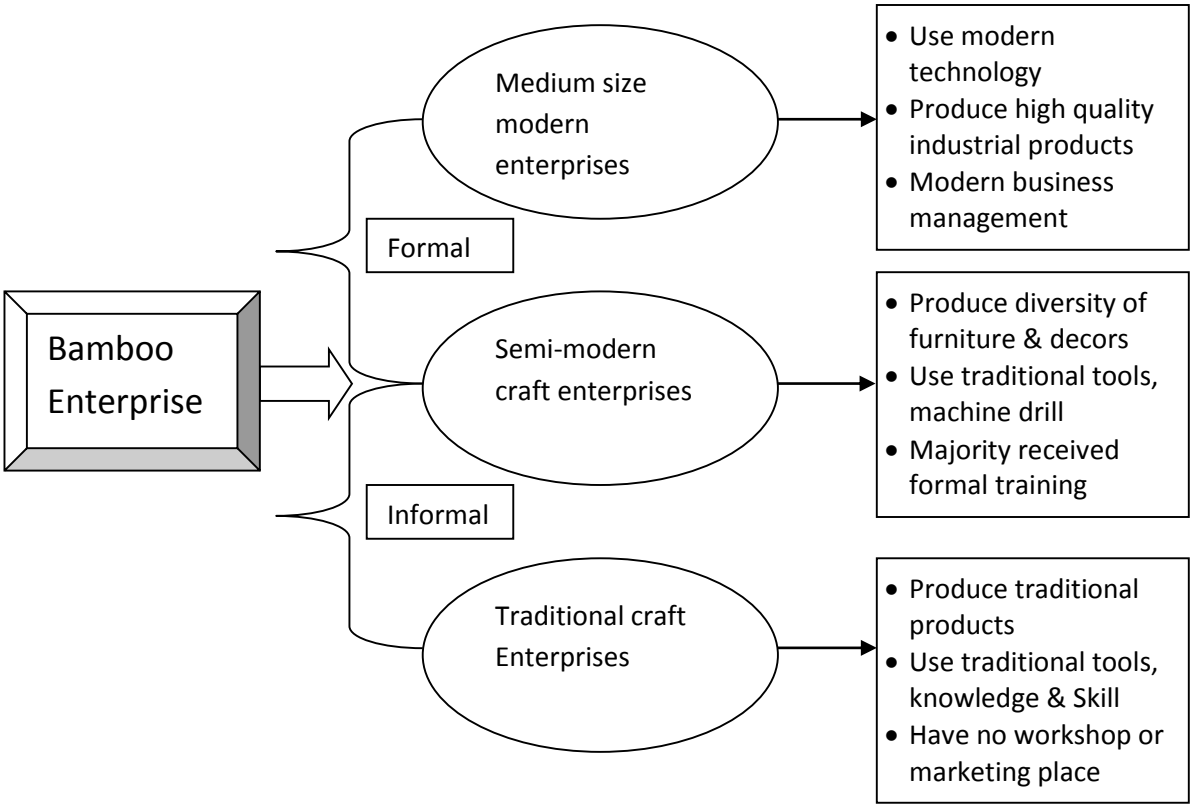


Figure 5.1: Classification of Bamboo enterprises (Source: Expert interview and group discussion)

Level of formalization is another defining criterion of bamboo enterprises. Formalization in this study is defined based on their registration title as an enterprise with their respective city municipality or other government offices. However, registration strictly as a bamboo enterprise was not possible in Ethiopia as there was no such title in the SMEs lists. It was only in May, 2014 that for the first time the ministry of trade had given bamboo products a separate commodity code and it became possible to be recognized

as a producer of this product. As a result, formal bamboo enterprises previously had license titles as a wood and metal enterprise. It is reported that formality may lead to relatively better government recognition and support, such as working space, but may also lead to taxation. About 56% percent of the surveyed bamboo enterprises are informal. Of these, 80% are in Bahir Dar and vicinities, 20% in Hawassa and 53% are in Addis Ababa. This figure is in contrast with the national figure of SMEs formality level reported by (Gebre-Egziabher and Meheret Ayenew. 2010) where 86% are formal and only 14% informal. The Hawassa bamboo enterprises are closer to the national SMEs figure.

In Hawassa, a higher proportion of the entrepreneurs are registered than in other cities, probably due to higher incentives such as working and display site provisions. In contrast, entrepreneurs in Bahir Dar area are largely unrecognized informal businesses. Traditional crafters working on the roadside are normally considered as illegal. Legal registration is difficult as a city residence identity card is requested prior to registration (Box 5.1). It is also reported that there is a request for a minimum capital and a business plan. Due to these reasons several traditional craft enterprises fail to register and in turn to access government/NGO sponsored trainings and other support schemes.

The analysis of the informal enterprises demonstrates that they share many of the common characteristics and challenges of informal enterprises described in Gërxhani (2004; ILO (1972; Haan (2006); such as reliance on indigenous resources, non-modern technology, family ownership and management of enterprises, traditional forms of organization, labour intensiveness, ease of entry, skill acquired outside of the formal school system and working in an unregulated market system.

Irrespective of their formality, enterprises are also found to vary based on the level of cooperation and/ or pattern of association. With this criterion, they are classified into two major groups. The first is a voluntary grouping among traditional crafters largely established among family members or youngsters coming from the same village to cities and working together to mobilize resources, such as sharing tools and equipment, selling products together, working in the same place enjoying socialization and group protection of property from theft. Thus, they can be categorized as spontaneous types of association.

The second group is a formal grouping, initiated and supported by the state or NGO agencies with the aim of cluster-based enterprise development (government agencies call it incubation of starter enterprises into cluster). Recognizing this intent of the support agencies, craft enterprises often organize themselves based on kinship relation or friendship to be recognized as an association. They share supports rendered to them and presume as if they are an association. However, the reality is they work as a voluntary group

as mentioned in the first group above except this group have common assets and may have a group bank account to maintain their legal status as an association and sustain possible supports. Therefore, the association seems a nominal arrangement to appease the state or NGO who have an interest in association and industrial cluster development.

Box 5.1: Process challenges of formalization

Group discussants in Bahir Dar express their chain of barriers to legalization and the benefits thereof. The challenges start with confirmation of the presence of legal residence where the business will be established. In order to get the city dwellers identity card, the crafters reported that the municipality requests them to present a letter that states that they have already left their ancestral land. However, they have land holding and they do not want to leave their land holding to get city residence identity in Bahir Dar. Moreover, they are required to present a valid address in the city. Again, it is reported that their landlords from whom they rent a house were not willing to allow them to be registered as a tenant. Furthermore, the business is taking place outside and there is no legal working space to register. Without these formalities, no financial services, training and other government supports are provided. At the same time, training in bamboo craftsmanship is arranged for peoples from among the legal residents who probably have no interest and no plan to pursue business in the bamboo sector.

Similarly, when asked why the crafters will not receive support from promotion offices, one of the experts with the city enterprise development and promotion office said “when we ask them to complete all necessary formalities for formalization and registration in the municipality, they leave the city and travel to Injibara”-referring to one of the traditional centers of bamboo craftsmanship. After they stay during cropping season there, they will return back. Moreover, informal enterprises are moving from place to place and often crossing autonomous regional states who have different regulations and support structures. Experts from trade and industry offices reported that the informal bamboo enterprises are difficult to trace and provide with technical and financial services. The experts further added that despite the advantage they may get, the enterprises’ refusal is considered as an escape mechanism from taxation. It is reported that registration may not necessarily lead to taxation or high taxation, as taxes could be temporarily waived or reduced depending on the economic stand and business maturity of the enterprise.

Source: Enterprise interview and group discussion

5.4 Bamboo Products and Processing Technologies

It is revealed that three broad categories of bamboo products are produced by craft enterprises: bamboo furniture, household utensils and house décor and constructions. Within each category, a number of deign variations have been noted. For instance, the types of chairs and sofas are quite diverse in terms of design, raw material combination, size and decorations. Although the list may not be exhaustive, since they have

not recorded all the products, the survey response and observation in the respective craft shops show 46 different types of bamboo craft products produced by the enterprises (Table 5.4).

Table 5.4: Most common bamboo products produced by craft enterprises and recorded from craft workshops

Utensils & crafts	Furniture Products	Décor & construction
Grain store	bamboo stool(Duka)	Wall
Lampshade	bamboo sofa chair	Flooring
Flower vase	Dinning chair	Cornis
Water container	Arm chair	Bamboo partition
Umbrella	3-seat chair	House decorations
Walking stick	Bamboo table	Satara/bamboo mat
waste basket	One leg circle table	Recreational house
Lemat/ eating plate	Dining table	Kerkiha Gojo (hut)
Moseb/Mosebewerk	Bamboo shelves	Bamboo planters
Candle holder/shade	Commodino	Chicken cage
Zenbil/bag	Cupboard	
Flower vase	Buffet	
Candle holder	Balcony and grocery shelf in single set	
Coffee cup	Television stand	
Fruit service	Bed	
Coffee bag	Child bed	
bread service		
Fruit basket		
Service trays		
Cotton spinning device		

Source: Enterprise interview

Processing of bamboo takes place in workshops and at roadsides. Traditional bamboo enterprises do the processing mainly at the roadside. On the other hand, semi-modern enterprises have craft shops and carry out the processing in these shops. However, most of them have no separate shop and display places. Moreover, about a quarter of them have a living room which is also used as a craft shop. They usually use the road side as an extension of their workshop and display place to sell their products. About 78% of semi-modern craft enterprises work in a rented house. The rest work in their own house and government donated working places.

Asked about their production specialization, half of the semi-modern craftsmen do not think they have specialized products, arguing that it is dependent on the requests. However, about a third of the semi-

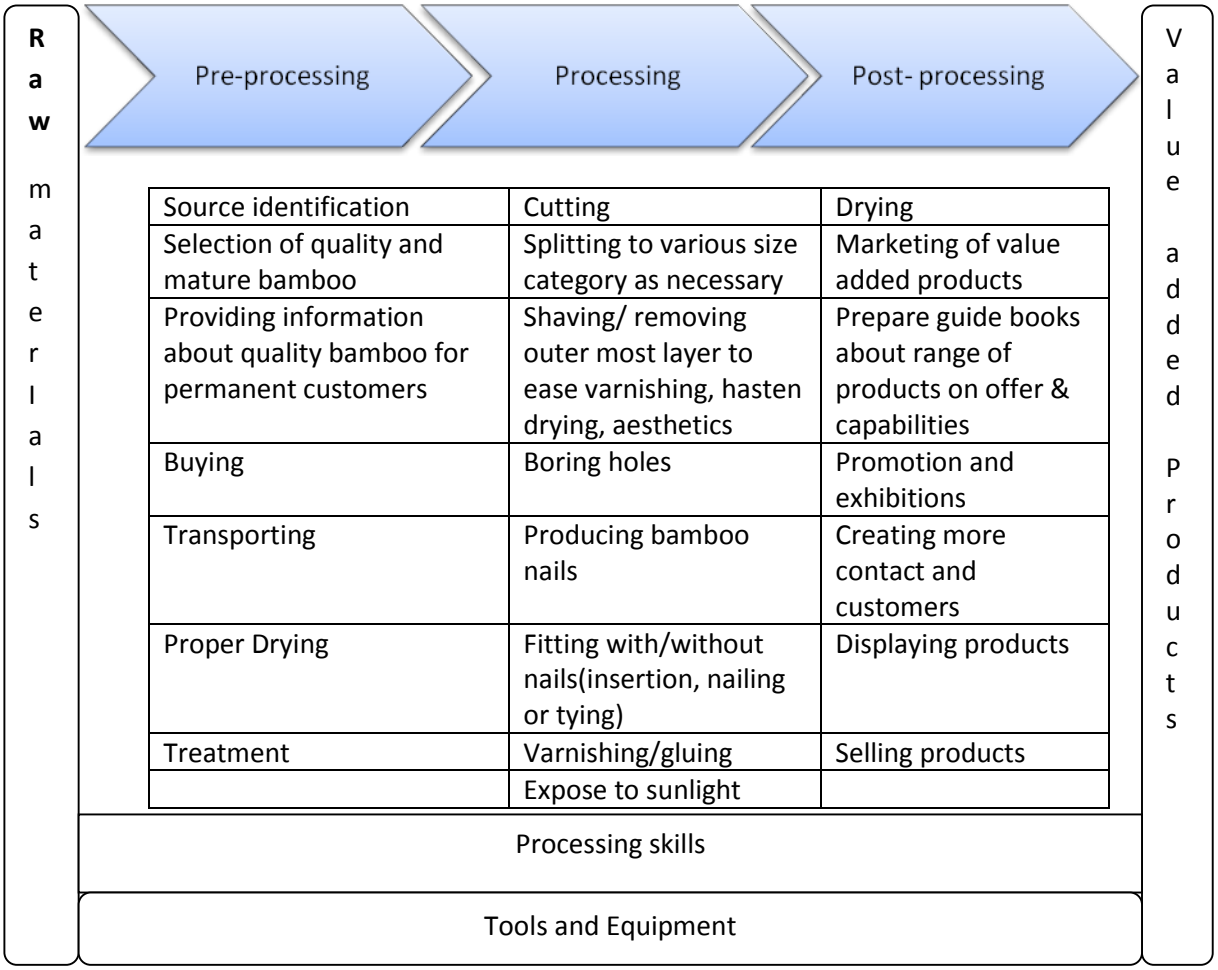
modern enterprises mention sofa chair as the most commonly requested and hence they think it is their specialization product. Other mentioned specializations include beds, shelves, chairs (especially *Duka*) and tables, lampshades and decorations. In the case of traditional crafters, their specialization is production of three seat chair and small stools. Asked why they specialize in these products, 90% say it is due to customers' demand.

The steps and major practices in the production of craft products were elaborated by group discussants. Though there are a great number of micro-variations in processing a specific product, it is found that the general steps and activities in processing of a product fall into three classes: preprocessing, processing and post-processing (Table 5.5). However, construction of bamboo houses follows a different work procedure, setting and managerial role of craft enterprise as described in section four.

All traditional and 23.7% of semi-modern craft enterprises use mainly hand tools. The remaining enterprises use power operated drills and one of them uses a stand drill. 19 different types of hand tools were reported to be used by semi-modern craft enterprises (table 5.6). Cutting saw, splitting knife, chisel or alternatively drill and measuring tools are the four basic sets of most frequently used tools and equipment by all craft enterprises. Traditional craft enterprises do not use precision tools such as plumb bob, framing square etc and varnishing tools and materials as they hardly varnish their products. Asked who the manufacturers of the tools and equipments are, all respondents answer that most hand tools are locally made. Few of the craft workers produce their tools and equipment by themselves.

Craft enterprise owners were asked individually and during group interviews whether they need and know alternative technology that they prefer to enhance their products' quality and efficiency. All crafters reported that they are aware of the presence of high quality machines and report that theirs are not comparable with the types they have heard about. Moreover, a couple of them reported that they had requested the FeMSEDA to buy one for them, which they report that FeMSEDA bought and kept for itself. Attempts have failed due to internal disagreements among craft enterprises about the practicality of using a machine in a group (Box 6.2).

Table 5.5: Steps and activities performed by bamboo crafters in product processing and marketing



Source: Group discussion with enterprises

Discussants further highlight that machines have several advantages than manual tools. It is reported that they reduce manpower requirements and can be used even in old age, are less tiring, increase the quality and uniformity of the products and enhance speed of production. They also report that it eases specific tasks such as designing, smoothing, cutting and compression. Thus, it seems that there is no awareness problem of technological levels and requirements amongst the enterprises.

Table 5.6: Commonly used hand tools and equipment in bamboo processing by craft enterprises

Measuring tape	Drill, stand drill
Chisel	Splitter
saw	Varnishing tools
Jigsaw	Carpenter's pencil
Framing or carpenter's square	Grinder for sharpening
Construction calculator	Finishing tools
Plumb bob and string line	Sand paper
Hammer	Scissors
Knife	Utility knife
Compressor	

5.5 Patterns of Linkage with Suppliers and Customers

Like other enterprises, bamboo craft businesses have forward and backward linkages for raw material sources and value added products. The major raw material for bamboo product is culm. It is obtained from different bamboo producing areas. Four locations are mentioned as a primary source of raw material for crafters. About fifty-six percent of respondents obtain culms from the Guragie area; while slightly less than half and a third of the respondents use raw materials from Awi and Sidama respectively (Table 6.7). A small number of respondents obtain their raw material from the Tikurinchine area. However, all respondents mention that they get raw materials from other sources through trade or by other means though less frequently.

Processed bamboo products are mainly sold in the city of production. Thus, most bamboo raw material once transported to the cities, the remainder of the chain is completed within the cities.

Asked about the reasons for the choice of raw material source selection, respondents mention distance (56%) and cheap culm price (38%) Durability (25%) and aesthetic quality (12.5%) as primary reasons (Table 5.8). The survey further shows that quite a large number of enterprises use bamboo from Awi due to low buearocracy on resource access and the presence of regional affiliation, especially for the case of traditional craft workers. On the other hand, many craft enterprises choose Sidama bamboo because of high quality (Endalamaw et al. 2013). However, it is reported that there are access restrictions for Sidama bamboo especially for enterprises from Addis Ababa. Moreover, the fact that Sidama bamboo has a better quality than others and is not far from many of the southern tourist destinations, many recreational

enterprises, government and large bamboo processing firms obtain their raw material largely from this district. As a result competition is stiff for craft enterprises.

Table 5.7: Primary sources of bamboo raw material for craft enterprise (n=32).

Primary source location*	Response	
	No.	Percent
Guragie	18	56.3
Awi	15	46.9
Sidama	10	31.3
Tikur Enchine	4	12.5

* Respondents from Awi and Sidama obtain their culms from their respective regions

Table 5.8: Reasons for the choice of raw material locations by bamboo craft enterprises (n=32).

Source region	Respondents'	
	No.	Percent
Short distance	18	56.3
Cheap culm price	12	37.5
Durable bamboo	8	25
Good aesthetics	4	12.5
Absence of restriction	3	9.4
Obtain in sufficient quantity	3	9.4
Difficult to get Sidama bamboo	2	6.3
Big culm size	1	3.1
Have family ties	1	3.1

More than half of the craft enterprises do not have permanent suppliers. These crafters believe that this type of relationship helps to freely negotiate prices and quality. On the other hand more than a third of the respondents have at least one permanent supplier. These respondents believe that having permanent customers reduces transaction costs (transaction can be completed by telephone), reduces suspicion about raw material quality and maturity and avoids searching for another supplier which may take time.

It is found that the majority of the enterprises sold their processed products to middle class and poor urban customers for mainly household use. Half of the enterprises also mention businesses, which include restaurants, cafes, coffee houses and hotels, as their main customers. Many of the respondents also think that business buyers are growing market niches and transaction with them is considered attractive as they buy in a larger volume than own consumption. Nearly a quarter of the craft enterprises mentioned foreigners living in Ethiopia as their customers, albeit they said that foreigners buy less frequently. It is also further reported that foreigners were their major customers in the past, but have recently shifted to traditional wood furniture instead of bamboo as their interest for bamboo has reduced. Thus, business

customers are increasing while foreigner customers are decreasing. 12.5% of respondents, all of them traditional craft enterprises, mention shoe polishers as their major customers. Shoe-polishers working at road side usually use low cost bamboo chairs for their customers' seat as a quality service while they often work sitting on stones (Table 5.9).

The types of customers listed are not mutually exclusive. For instance a business owner could be middle class or a tourist. However, this form of presentation helps to visualize the purposes for which bamboo is bought.

Table 5.9: Major bamboo enterprises' customers (N=32).

Customer types	No.	Percent
Middle class city dwellers	22	68.8
Poor urban dwellers	19	59.4
Business organizations	16	50
Foreign citizens living in Ethiopia	8	25
Different organizations	5	15.6
Tourists/travelers	5	15.6
Farmers	5	15.6
Shoe polishers	4	12.5

During group discussion, enterprise owners reported that buyers give priority for price and even their previous customers can shift to another crafter with small price differences irrespective of quality. Only after price negotiated and fixed those buyers often discuss on quality and aesthetic issues for the product to be bought. When the price is fixed at a terribly low level, crafters report that quality is compromised to maintain certain level of profit margin. It is further reported that this buyer behavior is the prime reason for setting the competition on price basis.

Similarly, most buyers interviewed do not buy bamboo products when quality is their major priority (box 5.2). More than half of them think bamboo crafts are low quality, less durable and low standard furniture. Majority of private bamboo consumers buy bamboo products since they believe it is cheaper (22) or relatively cheaper (5) than alternative products. When quality is their priority, they buy wooden furniture. Therefore, this attitude towards bamboo and their subsequent choice criteria often compromise quality for price. On the other hand, the motivation for buyers from hotels and tourism services for buying bamboo products or using bamboo decorations is a response to customer demand. Some of these interviewees respond that they used bamboo since it is a fashion or they see others are doing the same.

A comparison of furniture and recreation house craft buyers shows that there is no major overlap in terms of their reasons for buying bamboo products (Table 5.10).

Box 5.2: Processing quality reduces interest for bamboo products

All consumers interviewed have a positive attitude to bamboo and a clear reservation about the quality of existing bamboo products and utilization technology. Most of them would like to see increased utilization of bamboo. An hotelier in Addis Ababa report that bamboo products are liked by his customers and received encouragement when he use bamboo furniture in the hotel. However, he said that they are beautiful only in the display place and for a few weeks in his hotel. After some time, the fittings become loose and the entire furniture start producing powdery substance where the floor looks like covered with Shiro (a kind of Ethiopian food staff). He thinks that it is not at all difficult to make the joints strong and do the necessary treatments for pests if they really want to stay in the business. A similar argument is reported from a tourist lodge owner in Arbaminch, South Ethiopia. Therefore, consumers argue that their interest for bamboo is constrained by low quality processing.

Source: Interview with consumers

Table 5.10: Primary reasons for buying bamboo products (n=38).

Reasons for buying bamboo products	Private customers (n=30)	Business customers (n=8)	Total
They are cheap	22	3	25
They occupy relatively smaller space	6	0	6
Transitional/temporary purpose	6	0	6
Customers like it	0	6	6
Attractive	1	4	5
Reasonably lower price	5	0	5
Fashion	0	2	2
Have no idea	2	0	2
Durable	2	0	2
I like bamboo	0	1	1

5.6 Business Barriers and Opportunities

It is found that bamboo craft enterprises are working under a wide array of internal and external constraints. However, working equipment and limited skill and education are mentioned by majority of

the respondents. Slightly less than half of the respondents cited financial constraint (46.9%) and display places (43.8%) as primary obstacles (Table 5.11).

Though by smaller number, administrative problems such as corruption and bureaucracy are also mentioned as limiting factors. Specific bureaucratic issues mentioned by the crafters are illegal and delaying practices during harvest, transportation, workshops' site and tax administration. While financial constraint was not the most frequently mentioned obstacle, the impact in reducing or aggravating the other factors is mentioned by one respondent who said: "if I have a good working capital, I can train abroad, rent a good display house or import quality bamboo machines that enable me to produce high quality products". The demand side of bamboo business was mentioned as a constraint by 12.5% of the respondents who think there is low interest in bamboo. One respondent said that "after passing a series of tedious tasks to produce high quality furniture or other products, our customers consider our products a low grade product made from reed (a similar plant but is known as less strong), justifying that buyers do not realize the craft quality and the strength of bamboo products".

Table 5.11: Major Constraints mentioned by Bamboo craft enterprises as challenges for growth (n=32).

List of constraints	Craft Enterprises	
	No.	Percent
Working tools and machine	23	71.9
Adequate education and skill	20	62.5
Financial Constraint	15	46.9
Working and display place	14	43.8
Rise in raw material cost	7	21.9
Low workers' skill & motivation	6	18.8
Transportation	6	18.8
Decreased availability of raw materials	5	15.6
Bureaucracy	5	15.6
Decrease in raw material quality	4	12.5
Low interest for bamboo products	4	12.5
Corruption	2	6.3

Raw material availability, accessibility (transportation), quality and high prices were mentioned by several craft enterprises. In most regions, where they are accessible and located in close proximity to towns, local consumption is high and bamboo areas are relatively small. On the other hand, places where a larger volume of bamboo resources are found, are too distant from major urban cities and as a result availability from these areas is constrained by high transportation costs. Access is more challenging particularly during

the rainy season since most of the roads to bamboo areas are all dry-weather roads. It is further complicated as most of the enterprises have no adequate capital to buy extra volume when supply and infrastructural conditions are good to hold stock to cover periods of scarcity. Bureaucratic hassles along the way from production districts to processing centers are also mentioned as another limitation for resource access. It is demonstrative that Ethiopia has a large resource base that usually dies at the growing places without being used. Thus, the underlying cause seems more of interplay between bureaucratic and infrastructural barriers than mere resource scarcity.

5.7 Enterprises' Income and Determinants of Performance

The survey showed that the semi-modern craft enterprises earn relatively higher net revenue than the traditional craft enterprises. The average and median earnings of the former is 3500 and 2000 Ethiopian birr (birr) per month respectively (1 birr= USD 0.0572). Income varies in a wide range between 500 and 20000 birr. Two of them reported that they will graduate to medium enterprises in three years time which implies that their annual income exceeds 1.5 million birr, the lower limit for medium enterprise. Earnings of semi-modern craft enterprises also vary among regions where enterprises in regional towns on average earn 1370 birr compared to 5230 birr for craft enterprises in Addis Ababa. Compared to Bahir Dar, enterprises in Hawassa are found to have a better monthly net income. This may be due to the fact that enterprises in Hawassa have a relatively better market for decoration and furnishing of recreational houses than those in Bahir Dar. The other reason may be that most of the enterprises in Bahir Dar mainly produce traditional products which are less valued by middle income and business customers. The traditional craft enterprise earns an average and median net income of 356 birr and 300 Birr per month respectively. Similarly, traditional craft enterprises working in regional cities earn the lowest income followed by similar enterprises in Addis Ababa. The majority of the enterprises said that their income from bamboo processing constitutes their livelihood without additional subsidies, though only marginally.

Socioeconomic factors affecting performance of enterprises, as expressed by net annual revenue, are analyzed via multiple regressions. The result reveals that the use of semi-modern technology, working location and entrepreneurs' age and innovation significantly affect performance at P=0.05 level (Table 5.12). On the other hand formalization, experience and basic education level do not affect performance of enterprises. Therefore, a support scheme to further modernize the enterprises may help improve net-earnings of craft enterprises. Similarly, working in Addis Ababa and producing innovative products has a higher propensity to improve income than those working in rural cities and producing traditional products.

It is not clear why experience does not have an effect on net-income, although it could have an effect on increasing marketing linkage and the production of quality products.

Table 5.12: Regression results of selected performance determinants of bamboo craft enterprises as expressed by monthly net revenue (n=32).

Variables	B	t	p-value
(Constant)	-1.084	-.885	.385
Innovation	1.454	2.223	.036*
Location	-.519	-2.460	.021*
Experience	-.071	-1.005	.325
Formalization	-.334	-.747	.463
Modernity	1.238	2.563	.017*
Age of owner	.556	2.241	.035*
Education level	.170	.409	.686

*significant at 0.05 level

5.8 Summary

The result shows that the bamboo craft enterprises are largely informal with a low number of employees working with low level of production technology. Most of them are working individually but largely in the same area. A few of them work as formal or informal clusters. It is also revealed that the majority of customers for processed products are organizations associated with tourism/recreation sectors and newly established urban dwellers. For traditional craft enterprises, shoe polishers, poor liquor businesses and other poor customers are found to be equally important customers. In terms of income from bamboo, Addis Ababa craft enterprises earn comparatively higher income than those in the regional towns. The factors that significantly affect net-revenue are working location, innovativeness, level of modernity of working technology and age of enterprise owner. Although enterprises in Hawassa receive modest support from the government, the fact that the craft enterprises in Addis Ababa earn higher incomes implies that location and innovativeness may be the major explanatory factors for the differences. Probably for similar reason, Bahir Dar is trailing far behind both cities. The survey further reveals that crafters are working in a challenging work environment, facing problems with internal capacity and financial constraints.

6 Bamboo Innovation Typologies, Actors and Determinants

6.1 Introduction

In the previous chapter, the diversity, economic condition, business motivation, growth opportunities and challenges of bamboo craft enterprises have been discussed. This chapter presents empirical insights about innovation perception, typologies, knowledge sources, actors and determinants. In a similar manner to the previous chapter, craft enterprises are the major focus area of analysis and results presented refer to them unless otherwise stated. Major aspects of innovation by other types of enterprises and institutions are dealt with separately.

6.2 Perception of Innovation

Before delving into the analysis of innovativeness, the perception of enterprises regarding the meaning and relationship of innovation with their business is analyzed based on data from likert-scale interviews. Understanding of their perception is essential since innovativeness may partly depend on perception of the concept and the significance of innovation for innovation actors.

The result shows that the majority of the respondents do not see innovation as part and parcel of their business. Differences are observed among different enterprise types in terms of their perception of innovation (Table 6.1). However, most enterprises do think innovation is essential for business development. On average, enterprises agree that there is limited access to knowledge. Access is largely affected by financial constraints and geographical distance. Moreover, most enterprises think engagement in innovation hinders their competitiveness. Their line of arguments is that innovation takes more time to think and several trial and errors are required to reach a better output. Yet, customers do not respond accordingly.

Table 6.1: Perception of various type of firms, disaggregated by enterprise type, regarding bamboo innovation issues on five-level Likert-scale (from strongly agree-1 to strongly disagree- 5).

Perception of innovation	Semi-modern (n=23)		Traditional (n=9)		Medium & parastatal (n=5)		Weighted average (n=37)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited knowledge for innovation	2.13	0.97	1.56	0.53	2.60	1.34	2.05	0.97
Limited access for quality knowledge for innovation	1.35	0.49	1.56	0.53	2.00	0.00	1.49	0.51
Innovation environment is not conducive	2.00	1.00	1.44	0.53	3.60	1.14	2.08	1.12
Innovation is essential for business development	2.48	0.79	2.11	0.33	1.00	0.00	2.19	0.81
Innovation is part and parcel of the business	3.39	0.94	4.00	0.00	1.20	0.45	3.24	1.14
Innovation is priority	4.78	0.42	4.89	0.33	1.60	0.55	4.38	1.19
Business survival not innovation is my priority	2.48	0.99	1.56	0.53	3.00	1.41	2.32	1.06
Innovation obtained by chance	3.83	0.58	3.89	0.33	3.80	0.45	3.84	0.50
Competition hinders innovation	2.13	0.92	1.56	0.73	3.40	0.89	2.16	1.01

6.3 Types of Innovation by Craft Enterprises

The study shows that the total number and types of innovations reported in the craft enterprises are low (Table 6.2). However, given the various constraints mentioned and the fact that several craft businesses conduct bamboo production largely with limited technological support and internal capability, the innovations reported are promising.

About 40% of the craft enterprises think that they have introduced improvements in their products or production system. However, following the definition of newness and typology of innovation by OECD (2005), Voeten et al. (2011), Varis and Littunen (2010) and Amara and Landry (2005), only 16% are real innovators (Table 6.2). These craft enterprises have introduced innovation in the last five years in product, design, technology or market style compared to those existing in the center of production and marketing cities. Most of the innovations are in new product or designs. There is no organizational innovation reported.

The innovations are largely incremental and only a few could be considered as of radical types. Examples of the latter are: production of *gebeta* (food serving utensil) which was in the past exclusively made from grass and occasionally from wood or reed, the use of steam from the baking of *injera* (a thin fermented bread of Ethiopians) for preserving bamboo, and modification of the machines and hand tools from wood machines or foreign bamboo machines to suit their own needs. One enterprise has also introduced a new marketing style by opening several selling points in the city.

A comparison of the number and type of craft product types produced over a five year period (2007 to 2012), shows that 84 % of them have registered a higher number of products in 2012 than in 2007, while 6% has reduced their number of product types specializing in small, profitable products, and about 10% are still producing more or less similar types of products. All producers who do not change product types and a couple of those who diversify have also reported that they have improved the qualities and designs of similar products. However, this does not mean that all these craft enterprises have produced innovative products or designs over the years. Most of them diversify product types or designs through copying from innovators and early adopters.

Table 6.2: Innovation by craft enterprises disaggregated by type of the bamboo enterprise (n=32).

Firm type		New design	New product	New machine	New market	Total
Traditional	New to the firm	0	2	0		2
	New to the city	0	0	0		0
Semimodern	New to the firm	8	5	1		14
	New to the city	3	1	1	1	6
Total		11	8	2	1	22

Moreover, the mean number of products produced by craft enterprises has increased from three to eight between 2007 and 2012. However, when comparison is made only among semi-modern enterprises, it has increased from six to nine. Therefore, within this period the number of increase in product types is lower in semi-modern craft enterprises compared to the average increase. This may imply that the semi-modern enterprises have already started innovation or diversification practices well before 2007 and produce a larger number of products compared to the traditional crafters. Moreover, semi-modern enterprises often maintain existing product types by improving designs. There are also enterprises which reduced product diversity by specializing on a few profitable products. On the other hand, most of the traditional craft enterprises are younger than five years and they often start with a small number of products, resulting in the lower number of products in 2007. The process of changes explained in box 6.1.

Box 6.1: Changes in Product diversity in craft enterprise.

This case enterprise has increased products from 10 to 12. Items he used to produce in 2007 are sofa chairs, beds, shelves, dining tables, chairs, stools, partitions, commodes and decorations. No products that were produced in 2007 are absent in 2012. However, he added two more products: tourist huts and lamp shade. Both are highly demanded in recreational houses and tourism lodges. He argues that product diversification is not an issue for his business. One product may be enough if it is lucrative. What is important is the market condition. "If a buyer comes and orders me to produce ten different types of products, I will likely accept his request and start producing them as far as I have the skill and he is willing to pay me well. I can stop production of other products." Recently, the majority of the time, he is engaged in production of tourist houses, decorations and sofa chairs. The other products are produced occasionally depending on request and available time. He does not know which products will be the dominant ones after two to three months. He added that product designs are significantly improved over the years though they are known by the same name.

Source: Case study enterprise.

The reasons why they engage in innovation is also identified. As mentioned above, 16 percent of the craft enterprises engage in bamboo innovation and 74 percent of all enterprises believe in the need for innovation. The major reasons for those who believe innovation is necessary are presented in table 6.3.

These needs for innovation can be merged in to four major categories: (i) to improve sales (35%), (ii) to satisfy customers in order to survive in the business (35%), (iii) to improve competitiveness (27%) and (iv) to develop business and technology (16%). Business and technology development is emphasized by parastatal, promotion agencies and large enterprises. It is not surprising that parastatal and promotion organizations emphasize technology development since they are established primarily for technology development, training and dissemination, except tourist enterprise which is purely profit oriented. Private bamboo companies are also interested in technology development to facilitate international competition. Craftsmen, though they are aware of the significance of innovation, do not engage in production of innovative products or other aspects of innovation mainly because (i) they think that buyers prefer what they are familiar with, (ii) they work to survive and reach their aim through producing low quality products often at lower prices, (iii) they believe their training is not adequate to produce products that are entirely new, (iv) buyers do not realize quality differences and can be deceived by colourful varnishing and hence are unwilling to pay better prices for innovative products produced with a lot of effort, v) buyers are interested in cheaper prices and (vi) they can copy from other sources if buyers are interested in new products or designs.

Table 6.3: Purpose of innovation by craft and medium enterprises.

Reasons to engage in innovation	N=37	Percent
Sell at better price	6	16.22
Sell more volume of products	6	16.22
Sell faster though not in a higher price than low quality products	1	2.70
Satisfy customers	3	8.11
Attract new customers	5	13.51
Avoid customer loss	3	8.11
Survive in the business	2	5.41
Compete with imported (wood) goods	4	10.81
Compete internationally(export)	4	10.81
Develop the bamboo business	4	10.81
Reduce labour cost and energy	1	2.70
Develop advanced bamboo technology	2	5.41
To work in Addis Ababa	1	2.70

Craft enterprises are also interviewed in groups about the prevalence of innovation and to visualize the changes that have taken place in their respective enterprises (Table 6.4). The result shows that their innovations are largely improvements of foreign bamboo products and wood products within the country. Divergent and conflicting views are reported about who are innovator. Some of the crafters insist that products are similar and are often copied from other sources. Moreover, if one produces a different type of product or design, others will take it immediately and it becomes homogenized; hence, it is difficult to know the real innovators. Some others argue that it is easy to know who produced a certain product first and who imitated it. Their views about the quality of their innovation, extent of newness, challenges, competition and frictions are summarized in table 6.4.

Table 6.4: Most frequently produced innovations by craft micro enterprises and dominant views about the innovation processes and innovativeness based on group discussion with crafters.

Innovation Types	Dominant remarks/views
New designs	We are still using hand tools, for me innovation is using sophisticated technology like china bamboo factories. Government officials ask us to add more value. But they do not support us with adequate training that enables us to innovate and thereby add values on our products. Despite this, we have produced new designs. It is hard to memorize all by heart. We also produce new designs taking the prototypes from wood furniture.
Design improvements	What we do is more of an improvement of foreign designs and adapt to Ethiopian tests. New designs continuously pop up in your mind as you master the skill in sofa, bed or decorations. We have improved designs significantly in the last five years. You would not see these types of bed designs five years ago. My employees often take our innovative design when they leave. Crafters themselves also copy designs. The problem is not that it is imitated but they often fail to completely copy and yet reduce price for product that looks ours but of lower quality. No one has right to exclusively claim it is mine. After all we work by improving from foreign designs and there is no as such major difference and no ground to claim as own innovation.
Decoration of recreational houses (Ficus tree shape, dome shape, diversity of roof designs)	The nature of the work in recreational houses necessitates the production of different style based on purpose of the recreation house and the owners' preference. There are plenty of options for creativity taking the various regional house designs and modern houses. This work is financially more rewarding than furniture since they often pay us better. Thus, more innovation is made in these products than in furniture.
Technology improvement, new products	An interviewee with good machine and product innovation record said that by looking from Italian wood furniture machines, it is modified and adopted for bamboo. But he mentioned display and selling place as more problematic than the lack of machinery in the production of innovative products. Moreover, absence of mental stability due to poor market response to pay our bills distracted me from innovating further. If basic facilities fulfilled, we can also improve the processing technology as well.
Using Ethiopian traditional 'shema' (cloth) as a cover for sofa & Chairs	Traditional handloom products and embroidery are a spice for our product marketability. We also make use of their designs from handloom to embroidered bamboo table tops.
Decoration of furniture with diverse coloration of the weaving parts	We make different coloration to improve the aesthetics and appease our customer. Sometimes limited consumers awareness to recognize our effort reduces our motivation for innovation. Moreover, finance, low technology and absence of state support are factors that pull us back.

6.4 Innovation by State and Medium Enterprises

Due to the problem of comparability of craft enterprises with medium enterprise and state enterprises, a separate analysis of innovation practices and performance is made and results are presented separately.

6.4.1 Innovations by State Enterprise and Promotion Agencies

The tourist enterprise is the only profit oriented state agency. It is one of the major innovative enterprises in new product development, use of modern and easily available treatment techniques and diversification of products by blending with wood products and using wood machines. According to interviews with the bamboo experts, several innovation products and processes were registered. The first is the treatment of bamboo culms for durability. For this purpose, it has been using steam from *Injera* bakery by letting the steam pass through a chimney, treating bamboo placed in a bamboo treatment pool. All the ideas, design and implementation practices have been made by their own staff. It is further reported that the technology has reduced costs that would have been incurred for buying chemical preservation. It is also revealed that since large scale production of *injera* is common in the city, there is a good opportunity to extrapolate the technique to other *injera* baking firms with a provision of incentive for the space required to establish a pond. This is a radical innovation in the sense that it is not applied anywhere else. The organization of the flow of steam from bakery to the bamboo soaking pool is also innovative and it uses an otherwise wasted resource.

This enterprise has also produced new designs and significantly improved foreign designs for diverse types of local furniture and crafts. Moreover, it is reported that it has decorated and also constructed several cultural restaurants and parts of Hotel rooms and guest houses. It is also observed that, several furniture design, house construction and decoration styles have been produced by their own designers. However, recently, a downward trend in innovation is reported by the bamboo expert largely due to staff resignation.

Center for excellence in engineering (CEE) is another state organization established to be a center for bamboo and related product research, development and marketing. It produces prototypes of different products and designs. It is reported that products are produced by combining wood and bamboo to improve strength and aesthetics of produced products. They have produced several innovative designs in chairs, tables and beds and other crafts. Similarly, FeMSEDA has a mandate to develop new prototypes in products and technologies (machines). Accordingly, they have produced modified bamboo processing machine taking the Chinese machine as a model. They have also produced new bamboo products which

have unique parts compared to those observed in the craft market. Products produced in the workshop are sold in a separate display shop.

6.4.2 Innovation by Medium Manufacturing Enterprises

Among the three bamboo manufacturing medium enterprises, one is yet to start production and the other one is at the beginning of production during data collection. Thus, the data on these enterprises provides only information on establishment stage innovations and their preliminary activities towards innovation. On the other hand, the remaining one which is about 20 years old is in a better position to enable study of the nature and trend of business activity and innovation performances over the years. As a result, a detailed case study was made with this pioneer enterprise by interviewing the owner, manager and staff as well as visiting the various chains of activities in the factory. However, the newer enterprises are also described for comparison purpose and to draw an insight about their performance at the establishment stage.

Adal

Adal enterprise is a pioneer modern bamboo manufacturing industry in Ethiopia. It has about 110 employees, about 30% of which are reported as permanent. The annual capital is estimated at 250 million Birr. The major products produced include: bamboo floorings, curtains, charcoal briquettes, saw dust briquettes, incense sticks and tooth picks. It has also recently started supplies of raw sticks; bamboo saw-dust and charcoal power to foreign firms.

It is revealed that his company reached to the present state through a series of product, technological and organizational innovations. The company started as an aromatic product producing enterprise which was producing incense sticks manually since 1989. It then upgraded by one stage by introducing sanitary toothpicks which are produced by machines in 1995. The company has further modernized his production system and significantly diversified production in 2004 with the introduction of a number of modern bamboo technologies from the Far East. The company has added floorings and various types of mats to its list of products. Recently various bamboo charcoal products have been produced using the waste remaining from the flooring and mat production which help to further diversify production and reduce wastage (Box 6.2).

Box 6.2: Innovation in bamboo charcoal production.

Though charcoal is the primary energy source for rural and urban households and abundantly produced from hardwoods in Ethiopia, bamboo was not a preferred raw material. The use of charcoal is promoted recently. The reasons reported are to reduce the pressure on hardwoods, the quality of bamboo charcoal is found in par with wood charcoal and converting bamboo to charcoal reduces the cost of transportation.

Due to this, bamboo charcoal production and technology transfer is reported by Adal enterprise, and experts from INBAR and Ministry of Energy as one of the recent innovations. Adal enterprise produces charcoal from a waste products remaining from the production of flooring and incense stick. The owner believes this reduces the wastage percent by at least 10 percent and increase efficiency with nearly the same percentage. The technology is innovative since it was not used before in Ethiopia and that only the wastes are used for this purpose. He did not request training support as the technology is not new in the country. He however acknowledges that the knowledge of bamboo for charcoal was imported. Produced Charcoal is sold as briquettes and powder form. Products are exported and have adequate market.

Similarly, bamboo charcoal production technology is introduced and promoted by INBAR and Rural Energy Development and Promotion Center. According to the expert from INBAR, this is a technology transferred from China where processing kilns and application procedures are imported. Interviewed experts from both organizations report that since farmers are familiar with wood charcoal production technology, introduction of bamboo charcoal was not difficult. At the beginning the farmers argue that bamboo is too flammable and not suitable for charcoal. However, after a single demonstration the farmers accept that the technology works. They also advised to use the charcoal produced during training in their house and realize that it is as good quality as wood charcoal. A total of 2000 farmers also trained as pilot households. It is reported that farmers have started production of charcoal and supplying for charcoal traders. It is reported by the experts that there is adequate market in nearby cities. Therefore, since the technology is quite familiar and the fact that there is local and international market for charcoal without stringent quality criteria unlike the floorings, the innovation likely grows in faster pace than the other bamboo products.

Source: Adal enterprise and expert interview.

It is noted that all the products produced are either sold locally or exported. One distributor (wholesaler) buys all types of the company products and sells to retailers or exporters. There is no market scarcity. It is disclosed that at times production volume is much lower than the demand. To enhance production volume in response to the growing demand, it is planned to expand production. The company is highly focused on firm level practices and hardly worked on improving the raw material side of the supply chain. He thinks that if he works on the raw material side of the value chain, resources and focus will be disperses

and do not see the significance so far. It is highlighted that earlier attempt to establish partnership with bamboo farmers has failed. Despite this, it receives a regular supply of raw material without travelling to production areas. Several established customers bring direct to the factory. The company produces different types of products which are processed from various quality class raw materials; thus, most bamboo culms received can be used in one of the supply lines. As a final control, either the operational manager oversees the quality and provides advice to the suppliers to improve in the next round, or if it is too low a quality to use, it will be bought at a low price. Thus, the company manages the supply side by this type of arrangement.

Asked about his view about innovation, he believes in the need for innovation. However, he argues that foreign firms are producing more innovative products much faster than his company does and are accessible to imitate. So focusing on their new products and trying to produce similar products is economically justified. He said “I have no engineers like they have and competition at innovation level will not be economical for my company”. He asserts that his products and means of productions are new in Ethiopia. Thus, it is an innovative company only relative to Ethiopia.

Among five staffs who are interviewed in the company, four of them are employed in the last three years and have reported that no new products have been introduced since their employment in the company. The fifth, a senior staff member, has mentioned that two new products and several machines have been introduced in his working tenure. All of them reported that workers have no role in the introduction of the product, the machines or organization of the enterprise. They only produce products based on the protocol they are given to produce.

African Bamboo

African Bamboo plc started as a private company since 2009 to produce mainly bamboo panels for outdoor decking, indoor flooring and container floor boards for the export market. The company objective according to the interviewed experts is to innovate the entire bamboo chain. To this end, they organize farmers into cooperatives and unions to guarantee regular and quality raw material from different regions. It is also reported that the quality of raw material and processed samples are being tested in the laboratory so as to maintain a sustainable high quality product supply for their envisioned European and American consumers and to compete with China.

Although the experts said that they will start actual production in 2013, they are still doing a study on raw material quality testing. While the pilot research activities, market study and contractual arrangements

show encouraging innovative processes, it is challenging to analyze its future contribution to innovative development of the bamboo sector based on preliminary and establishment phase activities. There is also discordance in the views of the company's experts and the supposed members of the farmers unions. Farmers' group discussants in Sidama view the company as one of the training organizations giving them a onetime expert advice instead of as a business partner which is still working with them.

Bamboo star

Bamboo Star Agroforestry PLC is established in Asossa city, the capital of Beneshangul-Gumuz regional state. The largest bamboo resource of the country is found in this region. Despite the enterprise has about 400,000 ha natural bamboo forest, it has initiated its own plantation scheme to guarantee future supply and reduce pressure on the natural stand. Similarly, the manager discloses that they planned to provide seedlings to local communities to plant by themselves. Later, the company will buy from them at premium price if they produce quality and mature bamboo culms. The owner also reports that since the bamboo variety in this region grows relatively slowly and requires this type of pre-planning unlike the highland bamboo which only requires three to five years to produce commercially useful matured bamboo. Therefore, they are also working to secure a regular raw material supply. The company is currently producing similar products to the Adal enterprise and therefore no product innovation is reported.

In summary, Adal has given more emphasis to new product development and the introduction of new machinery to utilize existing product categories, while African Bamboo at production level innovation such as out grower scheme. Bamboo Star has a tendency to improve both raw material and the company capacity to compete with pioneer enterprise and enter foreign trade (Table 6.5).

Table 6.5: Comparison of business strategy and innovation propensity by the three enterprises.

Indicators	Adal	Bamboo star	African Bamboo
Product development, R&D, innovation	No R&D, manager assess new technologies and introduce appropriate one from foreign sources	Consultancy, in the short term no new product development planned	Consultancy, raw material quality development, prototyping and quality taste of possible products is underway, market assessment and quality assurance
Raw material quality and security	Less emphasis on raw material development, believes there is still enough, they sort out the different quality class and use for various categories of use	Assist farmers to plant and buy in premium price, provide seedling, secured land for own plantation, employees in the factory (out grower scheme)	Plan for out grower establishment, own plantation
Organizational innovation	A few trained personnel, the rest technical and labor workers	More similar to Adal PLC	Had staffs with diverse expertise and nationalities
Market destination	Mainly local market, export	Foresee both export and local	Foresee total export market
Policy and governance constraints, absence of identification code but recently bamboo is coded as separate commodity	The designation and associated rules which abide bamboo utilization as forest product are not fair	No problem	Bamboo raw material access rules Policy need to recognize bamboo as a grass

Source: Own summer based on the interviews of medium enterprise

6.5 Institutional Actors and Innovation Support

6.5.1 Institutional Actors and Support Initiatives

Several government institutions were established to strengthen the technological capability of SMEs in particular and the national science and technology system in general. Bamboo craft enterprises are recognized as part of the wood sector SMEs. In FeMSEDA, bamboo is separately recognized and organized in a separate unit. FeMSEDA, TVET, TTC, MOST, MOUDC, MOI, MOARD and recently MOEF have a direct stake in technology development and support of bamboo sector activities (Figure 6.1).

MOARD and recently MOEF are involved in sustainable development and conservation of bamboo resources through projects such as East African bamboo, sustainable land management in collaboration with other actors and donor support. They also contribute in capacity building activities in collaboration with NGOs and donor agencies such as GIZ, Farm Africa and UNIDO. Though on a smaller scale, the vocational training institutes in regional states are also involved in training. The other agencies are working on developing the technology and facilitating investment flows and market access for processed products.

At processing level, FeMSEDA, is by far the most important state agency supporting bamboo SMEs especially in training and capacity building. It has provided a number of trainings to craft enterprises (Annex 10.6). As described above, they are also producing machines and bamboo product design prototypes. Recently it has established bamboo semi-processing machines as a pilot technology learning laboratory in Tikur Inchinie, Hula and Injibara. According to the bamboo team leader in FeMSEDA, these machines expected to help farmers to semi-process their products and add value which improves the income for the farmers and reduces transportation costs for processors or other users.

Endogenous technology development and facilitation of technology transfer is primarily led by MOST. Trade development, enterprise promotion, market intelligence and product promotion are done with MOT, MOI and MUDC. Incentive schemes are facilitated by the MOI for MNE which may bring new technology and contribute to local capacity development. Capacity development of enterprise actors for productivity and competitiveness is a cross-cutting role for most of the agencies above.

Similarly, it is found that more than ten NGOs have been involved in bamboo sector development of Ethiopia. Interviewed experts who are working for NGOs believe that they are the leading actors in provision and financing of trainings, awareness creation in bamboo utilization and promotion of the potential of bamboo. Care Ethiopia and Farm Africa provided start-up equipment for trainees to start the craft work. Experts also report that they have lobbied to persuade the government to give attention to bamboo development.

It is found that training is one of the major institutional supports with relevance to innovation that is offered by both Government and NGOs. These agencies think that training and capacity building of craft workers and farmers is the prime intervention area to develop the bamboo value chain and transformation of the sector. Figure (6.1) shows trainees from 1998 to 2012 by FeMSEDA in Addis Ababa and regional states in bamboo craft production and entrepreneurship. However, the data does not

provide complete information of trainings conducted in the mentioned period. It is found that the list is not exhaustive. During the interview, craftsmen disclosed several other organizations that were not included in the database but had participated in the provision of trainings. Notable among them are the Catholic Church, Care Ethiopia, Ethio-Swedish and GIZ. Moreover, recent trainings conducted by African bamboo project sponsored by European Union and common fund for commodities (CFC) were not included in the report. Nevertheless, this data provides relatively detailed evidence about the extent of trainings conducted, major sponsors and trainee distribution in the country (Table 6.2). It also contributes to the analysis of the numbers of trainees who decide to join the business after the training is concluded.

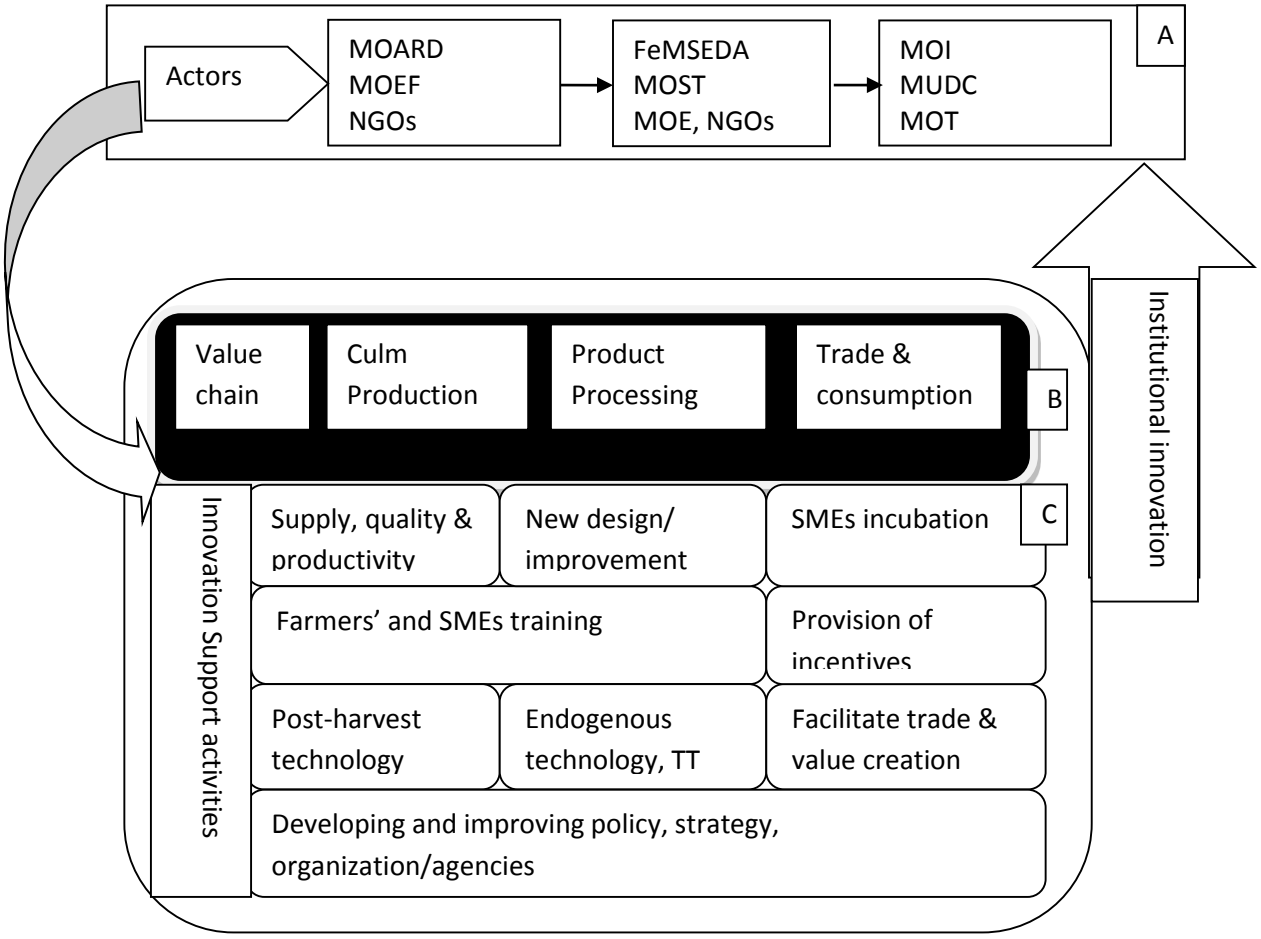


Figure 6.1: Institutional actors (A) and their role in supporting value chain (B) and innovation processes (C) along the production - consumption system. These actors themselves are also recently undergoing organizational innovation (annex 10.7).

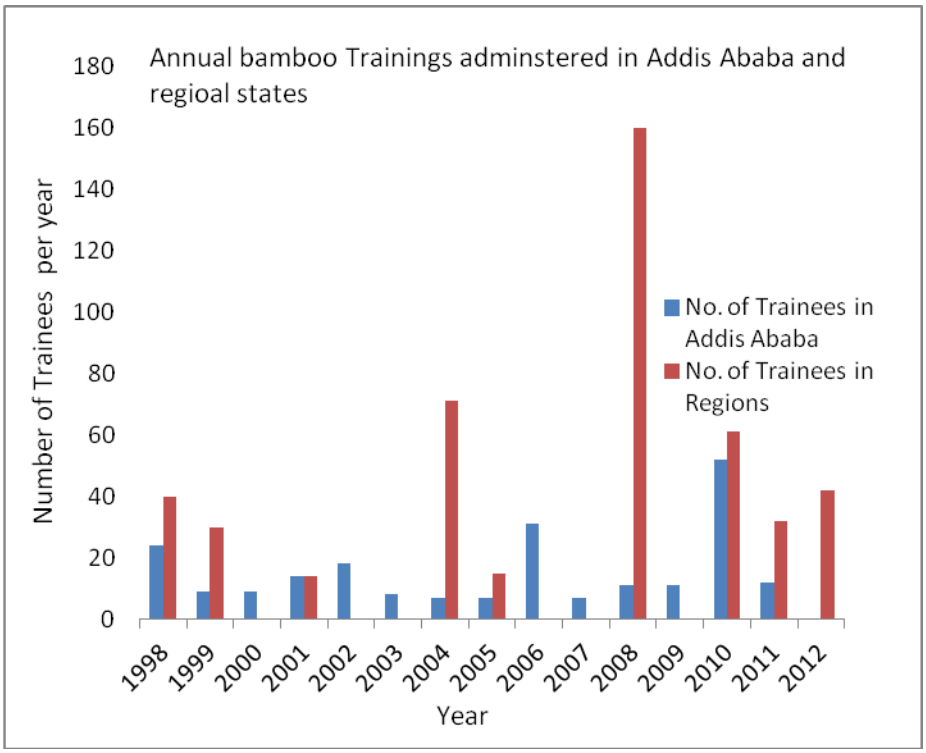


Figure 6.2: Bamboo trainings in Addis Ababa and regional states between 1998-2012 (Source: FeMSEDA).

The data shows that a third of all the trainees are from Addis Ababa and the remainder is distributed among the regional states which have bamboo resources (table 6.6). More than 71 percent of the trainings were sponsored by NGOs, 27% by government and the remaining 1% are self-sponsored. More than 22 NGOs participated in bamboo training sponsorship. Therefore, it can be seen that major contribution is made by NGOs rather than by the state or private sector in capacity building for bamboo craftsmanship. Government trainings are almost exclusively outside of the capital. MOARD trainings are given at district level where both bamboo management and value addition practices are included in training packages. On the other hand, trainings sponsored by regional SMEs promotion and development bureaus focus mainly on processing and training skills. NGOs' training programs related to all steps along the value chain. About 10 percent of the trainees were women. However, only one female headed craft enterprise was encountered during the survey in the cities and regions combined. There was one women's' association in Hawassa for a time which later went bankrupt and was closed.

Group discussants assert that, despite several trainings conducted, the number of bamboo trainees and the length of training hours are still insufficient to create a critical mass to transform the sector. Though there was no systematic monitoring to identify the extent take-up after the training, a comparison of total trainees and existing craftsmen and their trained employees shows that most trainees did not join the

business. Moreover, informal interviews during field work reveal that almost all rural trainees did not start bamboo businesses except those in Awi areas, the latter of which already have craftsmanship experience even before they attend trainings. An expert in Bale mountain report that among 42 youths trained in craftsmanship, only two have started craft production.

Among the bamboo craft enterprises interviewed, only 56% of them did attend formal training in bamboo furniture and mat production. All the crafters working by experience also show interest for training. However, they report that they are often prevented from attendance either due to lack of legal residence in the city of work, which is not easy to get, or they may not have heard that trainings were arranged. Moreover, several traditional craft workers mention that there is bias in the selection of trainees where those without need and interest attend while those badly needing it do not. Thus, the trainings still need a further step to reach all the needy and increase the penetration rate to create a critical mass for bamboo transformation.

6.5.2 Institutional Innovations Relevant for Bamboo Sector

In addition to the firm level innovations outlined above, major institutional changes in the institutional and policy dimensions relevant for the bamboo sector development were analyzed based on government documents and expert interviews. The results show that a number of changes have taken place in their organizational arrangement, policy direction and community centered orientations to stimulate grass-root entrepreneurship and innovations. These innovations are largely aimed at creating an enabling environment for business to flourish through capacity building, improving infrastructures and avoiding hostile rules and regulations. The major institutional changes relevant for bamboo sector innovation are described below and detail summary is given in annex 10.7.

Forestry enterprise development initiative

The bamboo sector can benefit from the recent initiative in forest administration which transformed the protectionist approach of conservation to an enterprise based sustainable forest management. The Oromia regional state with the largest natural and plantation forest has taken the leading initiative. Several regional states are introducing this approach. It mobilizes forest resource management and marketing effectiveness and puts in place mechanisms so that local people benefit from the commercial use of the forest. A system has been put in place to make sure that at least 20% of benefits go to local people who are the primary agent for conservation and/ or conversion of the forest. It also developed ways to avoid over-utilization of the forest. This changes the sector from one of a protectionist approach

to conservation through applying a system of management which has created a better environment for forest product value addition and marketing than the previous regime. Bamboo based business has greatly benefited from these initiatives for several reasons. In the first place there will be no bureaucracy on check points along the transportation routes once necessary payments have been made at the raw material origin. Secondly, products will be promoted for more markets as the forest department evolves from forest manager to sustainable forest enterprise developer. Thus, bureaucratic hurdles may also be reduced by this arrangement. Moreover, bamboo has recently been given a separate trade identification code to facilitate its trade and dealing with external investors.

Small enterprise development initiatives

The federal and regional governments of Ethiopia have given due priority for micro and small enterprises as confirmed by experts and SMEs strategy documents (FEMSEDA 2012). Interviews with FeMSEDA experts show that bamboo is one of the seven sectors identified by FeMSEDA for promotional support. In addition to the ongoing activities, the agency is working to invite university graduates to join SME clusters. Moreover, the agency has recently started incubation based private and clustered enterprise development strategy taking the Indian experience as an institutional innovation source.

Initiatives to transform industry, science and technology

The Ethiopian government has established the Ministry of Industry (MOI) which was previously known as Trade and Industry and upgraded the industry wing to a ministerial level. Moreover, the former science and technology commission is upgraded to ministerial level. The mandate given for MOI was to transform the sector, as it is assumed that it will gradually lead the economy overtaking the role of the agricultural sector. In this role the ministry is required to support the evolution of the manufacturing sector into competent firms. It will facilitate development of agribusiness as one component. However, while the bamboo sector is expected to benefit directly from SME initiatives and strategies as described above, an interview with an expert in the Ministry of Industry which oversees large industry promotion reported that bamboo is not a priority product at the moment and few investors are interested in it. This shows that the institutional changes aimed at supporting bamboo are mainly those at SMEs level. However, even for large bamboo based enterprises, most incentives designed to attract large investors will eventually apply for them as well; including land for plantation, reduced income tax and tax-free import of production machines.

The Ministry of Science and Technology (MOST) works with the MOI, MOE (Ministry of Education) and other state agencies such as FEMSEDA and CEE to foster the competitiveness of the manufacturing sector through technology transfer and own innovation development. However, the policy document shows that priority is given to technology transfer rather than to the development of own innovation. It is reported that these ministries have also a mandate to favor foreign investors that are capable of transferring knowledge and technology.

6.6 Sources of Innovation

6.6.1 Knowledge and Technology Sources for Innovation

Knowledge essential for technological development could be sourced from within the firm or sector, external to the firm or external to the national innovation system (Iammarino and McCann 2013). Individual firms are seldom capable of innovating independently and that the search for new ideas goes beyond the firm's boundaries to other firms or institutions (Granero and Vega-Jurado 2012). Innovation theorists across sectors also underscore the necessity of inter/intra firm learning for innovation (Lundvall 2010; Edquist 2013; Spielman et al. 2008; Spielman et al. 2009). Moreover, studies show that external knowledge utilization equally depends on the capability of firms to properly select and adopt knowledge to their own institutional environment (Altenburg 2009; Zahra and George 2002). Thus, innovativeness of a firm depends on availability of knowledge and its appropriate selection and application.

Similarly, bamboo enterprises of Ethiopia, with a limited knowledge base, poorly established communication network, and virtually no R&D units in all firms; the need for external knowledge is quite substantial. Based on the survey results and further discussions with processors, producers and experts, the major sources of knowledge and skill for craft enterprises are identified. They include: indigenous knowledge, furniture catalogues, customer information, trial and error and copying from wood furniture enterprises (figure 6.3). The data further reveals that the majority of traditional craft enterprises gain the necessary skill and knowledge for creativity via networks of family and neighbors. Teenagers get the skill as an informal internship by observing and providing materials for crafters working in their community. Crafters report that their capability continuously improves over the years through trial and error taking various sources of information as a starting point. Most traditional crafters said that their customers are not a source of knowledge. This could be probably due to the fact that major customers are relatively less informed on how to produce a better quality bamboo product as they are mainly less educated rural and urban poor.

On the other hand, the majority of semi-modern craft enterprises obtain the skill through formal training mainly provided by NGOs or government. Internet is the second most importance knowledge source for semi-modern craft enterprises. These crafters report that whenever they want a new design for products beyond the one they are trained in or have known before, the internet is often the preferred source. It is also reported that they attend trade fairs and exhibitions to promote their products. However, they assert that they obtain little new information as enterprises attending the fair are those which they are already familiar with and are from the same city. It is also revealed that no knowledge or skill is obtained from national R&D institutes.

Buyers of processed bamboo products have been mentioned by a couple of semi-modern enterprises as a source of knowledge. Customers mainly provide crafters with new or modified designs to suit their specific interest. They also request crafters to produce relatively different products. Therefore, in addition to their importance as pull factor (incentive for innovative products), customers are also an important source of innovation. However, their role may vary depending on their level of awareness. The study further shows that semi-modern crafters have relatively wider sources of knowledge and skills than the traditional ones.

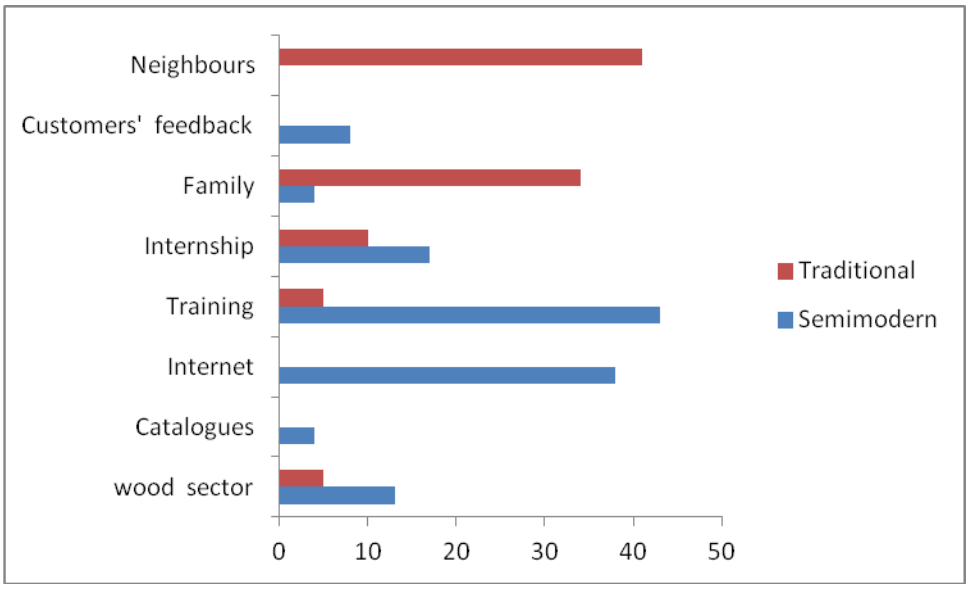


Figure 6.3: Percentage of primary knowledge sources for bamboo craft enterprises disaggregated by type of craft organizations (n=32).

However, looking at the broader perspective of knowledge base and extent of knowledge sharing arrangements, the knowledge sources are scant and acquisition mechanism is less explicit. Some of the

knowledge sources do not allow physical contact and do not provide adequate access to the whole set of tacit and implicit knowledge as well as the organization of the production system. Apart from one craftsman who had an opportunity to visit wood furniture making shops in Middle East, all of them had hardly any opportunity to visit and learn bamboo or wood craft works outside of Ethiopia. Even within the country, the majority of the crafters report that they did not visit craft practices outside of their respective working cities.

Asked about their sources of knowledge and technology for their business development and innovation, medium enterprises identified: customers, foreign consultants, companies producing similar or related products (networking), international development agencies, NGOs, commercial associations and organizations, scientists and technologists, mass media, internet, exhibitions, personal friends and experience sharing tours in Asia as major sources. It shows that these companies have a wider source of knowledge and resource to access knowledge sources compared to craft enterprises.

6.6.2 Innovation Networks as Sources of Innovation

Networks are a major arena for exchange of information and learning. Inter-firm and intra-firm networks are key to success in innovation as major new technologies are obtained at the interface of divergent views (Akrich et al. 2002; Tomlinson and Fai 2013; Beck and Wicki 2014; Howells 2006; Gronum et al. 2012; Maso et al. 2011; Ollonqvist et al. 2011; Pettenella 2011 #532}. Interviews about information network, types of network and their contribution to learning and innovation shows a statistically significant difference (χ^2 test, at 0.05) between semi-modern and traditional. The majority of traditional enterprises (66.7%) share experiences and resources among similar types of enterprises. However, semi-modern enterprises are loosely networked and only 17% and 8% share experience and resource respectively. Moreover, it is reported that information and skill flow takes place mainly among friends and family. It is revealed that information from those enterprises outside of the closed family/friend circle is usually obtained indirectly though staff mobility from one enterprise to another, and by observing processing at the road side and products on display. The survey further shows that sharing of resources and knowledge is smaller than market information (Table 6.6). Therefore, networking based on professional similarity beyond the traditional family line is poorly developed. On the other hand, adequate attention is given to networks with customers and report that they gain useful information from them. The fact that networks are weak and perception of their importance is less encouraging among semi-modern enterprises implies that there is a need to nurture trust among them to enhance the role of network for innovation.

Table 6.6: Percentage of enterprises sharing information, experience and resources (n=32).

Types of information exchange and benefits	Traditional (n=9)	Semi-Modern (n=23)	Total
Exchange information	66.7	65.2	65.6
Benefited from information exchange	66.7	56.5	59.4
Share market information	66.7	65.2	65.6
Share knowledge and skill	66.7	17.4	31.3
Share resources	66.7	8.7	25

Among all the respondents, only four, three from Hawassa and one from Addis Ababa are members of a bamboo based association (usually called cluster). The cluster often lacks the formal structure and relationship among members is more of an informal type. Respondents give several explanations for their indifference to association and cooperative work (Table 6.7 and Box 6.2). The responses are divergent but clearly show that most of the craft enterprises are less interested in formal associations.

Table 6.7: Craft enterprises reasons for low interest in cooperation with other enterprises for exchange of knowledge and innovation development (N=32).

Reasons mentioned for non-cooperation	Number	Percent
Every one work for his own	5	15.63
I do not know why	4	12.50
I am busy	3	9.38
The others are not willing	3	9.38
There are few whom we could learn from	2	6.25
Let alone for innovation development, discussion fail to fix fair price	1	3.13
No significance to discuss	1	3.13
We share less risky issues only	1	3.13
No need, we work in the same place and see each other's work without killing our time	1	3.13
They take my customers and not willing to work with them	1	3.13
Government could help us to organize and work together as we fail to do so by ourselves	1	3.13

Box 6.3: Failed Initiatives for Cooperation Establishment.

Two craft enterprise owners, one of them, a case selected for this study, took the initiative to facilitate the establishment of a craft workers association in Addis Ababa and collected signatures of the willing craft enterprises. The objectives were to: (i) collectively buy bamboo processing modern machines and use in rounds of a clearly defined schedule, (ii) discuss and find a mechanism on how to regulate unfair prices for value added products and (iii) mobilize themselves in a group as other sector enterprises do and request government and NGOs support. It was explained to possible members that this will pave the way for improved working conditions. Particularly, financial constraints for individual crafters to buy machines will be avoided; the adverse effect of disregard for quality and durability of products which is killing the business will be settled by cooperation. Convenient workshop and display places may be supported by government. With this explanation more than 8 crafters agreed on the initiative and signed on a temporary agreement form.

However, at some point counter rumors were distributed that it is an initiative: (i) to benefit the initiators at the expense of the majority and (ii) that leads to exaggeration of our business status and revenues which will in turn result in high tax imposition on us. These severely reduced the motivation of the crafters for cooperation. An attempt was made to diffuse the rumors by explaining that legal procedures will be put in place to protect unfair benefit distribution and detail business profile will not be reported to government. However, it was not able to bring about the required level of trust and the initiative failed. The initiator thinks that those crafters with higher capital and working by opening several display locations are those who oppose the move and are behind the rumors. It is also reported that FeMSEDA have made similar attempts to organize craft enterprises. A bamboo expert in FeMSEDA reports that competition among crafters is so intense that at times it has led to severe disagreements. As a result, closer cooperation among existing crafters is unlikely and even if established may not be sustainable. He thinks however that it is possible and advisable to train and organize new entrants in cluster form.

Source: Case study and expert interview.

6.7 Determinants of Innovativeness in the Bamboo Sector

This subsection explains various factors affecting enterprises innovativeness based on different data sources. In order to understand these casual factors data from enterprise surveys and expert interviews are analyzed and results discussed. The result reveals that over 13 different reasons are mentioned as a factor (deterrents of innovation) among which three factors, technology (machine, appropriate tools and equipment), finance (capital) and capacity (including skills, education and access for training) as the major factors mentioned by over 76% of the respondents (Table 6.8). Absence of government support and lack of quality training are mentioned by 25% and 22% of respondents respectively. Limited market availability, buyers' perception of bamboo as a low quality product, and their preference for familiar products are also mentioned by several respondents as barriers to innovativeness (Table 6.8).

Table 6.8: Factors hindering bamboo innovation by craft enterprises (N=32).

Causal factors	Semi-modern (n=23)	Traditional (n=9)	Total
Absence of technology and machine	50.0	12.5	62.5
Limited finance	25.0	15.6	40.6
Low Capacity	9.4	21.9	31.3
Absence of government support	9.4	15.6	25
Lack of quality training	9.4	12.5	21.9
Absence of working space	9.4	0.0	9.4
Limited consumer awareness	6.3	3.1	9.4
Loss of trained staff	6.3	0.0	6.3
Low staff motivation	6.3	0.0	6.3
High market competition	3.1	0.0	3.1
Buyers prefer familiar products	3.1	0.0	3.1
Livelihood pressure (survival)	3.1	0.0	3.1
Low market price for bamboo	3.1	0.0	3.1

These factors can be classified as those which affect the firm's motivation to engage or as factors which limit innovativeness. The factors in the first category include: finance, information, education and skill limitations, economic pressure to secure survival and rent, low market price for bamboo and poor staff motivation. On the other hand, absences of government support, low awareness of buyers or their preferences are largely external factors limiting firm innovation performance.

Though the two case enterprises do not have major deviation from the other enterprises surveyed, they emphasize a couple of factors as key deterrents of innovation. The first factor is demand. They argue that existing competition is price based mainly due to customers' demand for cheap products rather than quality. As a result, they iterate that, enterprise focus is shifted to how to cut costs instead of upgrading product quality and durability. There is no incentive to buy preservatives, varnish or taking time and resource for proper drying and processing while it will be sold for the same price as do products with low production input. One of the crafter highlights that he is inspired to continuously innovate, but often is discouraged by lack of price reward. Thus, absence of informed customers is identified as key factor deterring innovation performance of firms by case study firms.

To further understand the determinants of innovation, the relationship between innovativeness and socioeconomic characteristics of the craft enterprises is analyzed using regression analysis. The result reveals that only experience significantly affects innovativeness in craft enterprises (Table 6.9). Experience is a source of capability and organizational prowess in craft enterprises where the majority of the processes improved through learning by doing. On the other hand, education level, age, formalization,

training, government support and networks do not significantly affect innovativeness of firms at 95% probability. It is interesting that there is little relationship between innovativeness and development of networks, due to the fact that most of the semi-modern enterprises that have registered innovation are less networked than the traditional enterprises which are working in collaboration and enjoy several forms of cooperation. This however may not mean that networks do not facilitate innovation. It rather may be due to the effect of the content and channel of information flowing within networks (Granovetter 2001; Darr 2008). According to Granovetter (2001), weak networks could provide an indispensable opportunity depending on the content of information flowing through this type of tie. On the other hand, the most networked enterprises are subsistence enterprises whose clients are generally poor or people who want low quality products. As a result, they may not use their network for knowledge and innovation generation.

Similarly, training, government support and education which have impact of capacity building and which is important to innovation are not found to significantly affect innovation. This could probably be due to the quality of training and government support. Basic education may not directly contribute to innovativeness in craft enterprises. Enterprise owners have generally homogenous age profile as most leaves the business when get old. In general, the result can provide additional clues to identify important socioeconomic and entrepreneurial factors affecting innovativeness in bamboo based enterprises. However, it is important to accept the result with caution as the sample size is small to depict causal relationships with high degree of certainty.

Table 6.9: A step by step binary logistic regression analysis of factors affecting innovativeness (n=32; R2=33.8).

Variables	B	df	p-value
Experience	.858	1	.031*
Training	-20.173	1	.999
Age	-.072	1	.356
Formalization	20.615	1	.998
Education	.659	1	.502
Location	-1.234	1	.167
Innovation network	-.125	1	.900
Government support	-19.677	1	.999
Modernity continuum	20.247	1	.998
Constant	9.863	1	.024

* Significant at 0.05

The second source of data for identifying factors fostering or deterring innovation is the expert interview. Experts were guided to provide their views on internal capacity, technology transfer, policy condition, private sector development and other factors that they think are essential for or are obstacle to bamboo development. The result reveals that the majority of experts (77%) working on bamboo or related fields do not believe that innovation is underway in Ethiopia. The majority of them have believed that the bamboo building industry is growing and demonstrating innovations which may gradually be extrapolated to other products in the sector. Two experts mention bamboo charcoal production as another innovative product. Experts have outlined the major obstacles that limit bamboo innovation in Ethiopia as in table 6.10.

Table 6.10: Experts' view of factors affecting innovative development of bamboo sector in Ethiopia on a Likert Scale between 4 (extremely important) and 1 (less important) (n=26).

Conditions	Indicators	Mean	Median
Local capacity	Lack of technology generating institute	2.88	3
	Lack of adequate experts in bamboo silviculture and technology	3	3
	Low technological skill of bamboo processors	2.92	3
Technology transfer	Technology transfer efforts are project based and intermittent	2.46	3
	No strategy on how to transfer technology	1.92	2.5
	Limited capacity to adopt technology	1.6	2
	poor technology selection	2.11	2
	Assumption that technology transfer is easy and cost-effective	1.77	2
Policy condition	Limited promotion and incentive to attract innovative firms to the bamboo sector	2.08	2
	Resource size and location and accessibility are not attractive to investors	1.65	2
	Linkage among various actors is not cultivated	1.96	2
	Absence of permanent and strategic training support	2.31	3
Private sector condition	Dependency on donors and limited effort in developing internal innovative capacity	1.73	2
	Low awareness for bamboo products and subsequently limited national and regional market for bamboo products	2.54	3
	Produce low quality products and discourage buyers	1.31	1.5

The average response of the experts reveals that local capability of the nation in terms of human resource, technology institutes and enterprise skill are the major barriers to bamboo innovation and development.

Over 50% of the experts mention technology transfer as an option for Ethiopia. However, they also mention a number of obstacles (sustainability, absence of strategy, poor technology selection) that need to be solved for its successful transfer to the Ethiopian context. Differences are also noted among experts about technology transfer. Experts in the decision making areas believe that the process is started and going on the right track. Professional experts mention the presence of a number of challenges. Moreover, it is essential to note that although some points are not mentioned by many experts as important, this may not necessarily mean they are less important. It could rather be due to area of exposure and ideological disposition. Experts in silviculture may not see the technological problems or opportunities at the industrial level and vice-versa. Similarly, policy makers downplay the effective of institutional and policy failures as causes of stunted innovation performance in firms.

Technical experts mentioned policy issues such as absence of strategic training, sustained promotion and provision of incentives as important limiting factor for innovation. Most experts from decision making area rate these issues as less important arguing that there is adequate policy incentives for investors. Experts' responses further depict that low awareness of bamboo products and subsequently low demand is considered as important constraint for bamboo innovation.

6.8 Summary

Innovation is scarce, and scarcer in bamboo craft enterprises where business survival and fulfilling their subsistence needs are reported as a priority and working in an environment of numerous stumbling blocks. Even so, a couple of new innovations and several incremental innovations are produced by craft enterprises. Innovations are recorded with those with adequate experience in craft production and working in Addis Ababa. Enterprises and experts identified technological capability, customer demand for quality products, quality training for crafters and government support as major determinants for firm innovation. Experience is found the only factor to significantly affect crafters' innovation performance. However, the interview result with enterprises and experts reveal that innovation and development of the bamboo sector into a competitive business depends on the capacity and experience of enterprises, access to finance, appropriate technology and an enabling policy environment.

7 Bamboo Value Chains and Determinants of Commercialization

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7.1 Introduction

In the previous chapters, the traditional technologies, actors and determinants of innovation and entrepreneurship in the bamboo sector have been discussed. This chapter presents the various indicators that show the level of bamboo commercialization in the study sites and the country at large. The major factors that indicate bamboo commercialization are the level of management intensification, the strength of value chain relationships and the proportion of cash income obtained through bamboo sale. A number of socioeconomic, infrastructural and policy conditions that lead to differential levels of commercialization are also presented. Furthermore, the basic challenges and opportunities affecting innovative commercialization are synthesized in this chapter.

7.2 Bamboo Value Chain

7.2.1 Production and Management

The results from surveys along the value chain reveal that the bamboo commodity chain starts at culm production areas: these areas are natural bamboo forest in Sheka while managed bamboo lots, roadside and river bank plantings in Awi and Sidama. The results from interviews and group discussion depict that Sidama and Awi have a domesticated and relatively intensively managed bamboo production system as compared with Sheka, which is an entirely natural forest-based system. Moreover, the survey shows that all farmers in Awi and Sidama obtain their bamboo products from privately owned sources, whereas interviewed households from Sheka reveal that they harvest bamboo entirely from state-owned natural forest.

Appropriate harvesting is the only management practice from Sheka. On the other hand, a relatively diverse management practices are conducted in Sidama such as tending of natural sprouts, weeding, digging around to improve soil porosity, weeding or slashing of other species, culling or removing old or diseased individuals, and shading of newly planted bamboo. In Awi, further intensive management practices such as fertilization and protection from flooding and a cattle browsing is reported (table 7.1).

The amount of labour investment in a year is found to be higher in the domesticated bamboo production regions. The Sidama farmers invested the most man-days (2.57), followed by Awi (2.26), whereas an

average Sheka farmer is hardly engaged in bamboo management. Similarly, the number of people who are not involved in any one type of management is highest in Sheka (87%) compared with 5% and 3% at Sidama and Awi, respectively. The reasons interviewees mentioned in Sheka are that bamboo does not require management (73%), it is an open access resource and there is no incentive for management (52%), the resource is state-owned (38%), and interviewees would cooperate if the government takes the initiative (35%). The reasons for Awi and Sidama bamboo producers for engaging in management practices reported were to increase their income (100%), to improve culm diameter (27%), to speed culm growth (11%), and to identify mother bamboos for vigorous stands (1%). The responses are inherently similar, in that all interviewees aimed to produce a high-quality culm that would fetch better income or provide for better provisioning services.

Table 7.1: Bamboo management practices in Awi, Sidama, and Sheka districts of Ethiopia.

Management Type	Percentage of respondents*		
	Awi (n = 38)	Sidama (n = 43)	Sheka (n = 52)
Appropriate harvesting	21	19	13
Tending (thinning, weeding, digging, piling covers)	29	77	-
Protection against cattle	34	40	-
Fertilization	34	16	-
Introducing new variety	3	7	-
Protect from flooding	8	-	-

*An interviewee may practice more than one type of management.

Source: Endalamaw et al (2013).

Previous studies confirm that commercialization of a plant largely relies on the domestication of the product and subsequent management intensification so as to keep up with the demand and overcome quality variability (Leaky et al, 2005; Schreckenberg et al, 2006). Similarly, in this study, more labour is invested for the managed bamboo and a correspondingly higher proportion of products are sold compared to the resource obtained from natural forests of Sheka. The differences could be explained by the incentivization of labour inputs by a comparatively higher price of bamboo culm in Awi and Sidama. Thus, as domesticated production stimulates commercialization, commercialization is expected to provide financial incentive for the labour invested in domestication relative to wild harvesting.

7.2.2 Transportation, Processing and Marketing

Culms are transported by four major actors: bamboo owner/harvesters, processors, traders and tourist house constructors. Transportation from production area to marketing centers is handled by the bamboo owners, or as in the case of Sheka, by the collectors. From marketing centers, processors transport to the processing cities. These same processors can also travel into the plantation site and collect from there. The means of transport is truck often rented from other traders. Likewise, traders also transport culms by collecting direct from the production areas and/or buy from available market centers and transport themselves. Culms may be taken to respective craft shops if it is transported based on prior agreement and arrangements or to another market place as in the case of Addis Ababa- Merkato area where traders sale in their bamboo yard. Thus, smaller bamboo processors who are not capable of ordering a full truck load alone or with a friend often buy from traders in Mercato or in their respective cities.

Finally, bamboo recreational house owners transport bamboo culms direct from the production area by themselves. Often the house designers and constructors directly involved in the selection of mature culms in the production center and the culms transported by the recreational house owners vehicle or rented vehicles.

Processing of bamboo takes place in rural and urban areas. Households that own bamboo may engage in processing of basic household utilities such as furniture, utensils, and equipment for consumption or to give to extended family members. Most commercial processing takes place in urban areas with the largest concentration in the national capital, but also regional capitals such as Hawassa and Bahir Dar. The details of processing and production technology are described in the enterprise chapter.

Marketing takes place at two major phases. Bamboo culm marketing is conducted between buyers and producers at the production area, market centers and roadsides; and with traders in their respective wards. In Awi and Sidama, market is available at production site. Further transport by farmers is mainly meant to increase their market share in the value chain. However, in situations, where no buyers visited their area but have immediate market need or the amount of planned sell is too small for a trader to make a visit, they may wish to transport by themselves or donkeys to the nearby market center or roadside. Producers have a competitive advantage and normally little exploitation complain reported. This is because farmers are aware of the increasing demand for bamboo and negotiate strongly. Sometimes farmers even have exaggerated information about bamboos real price in the cities. Traders or other buyers once they travel to production area, they tend to accept negotiated price and settle transaction. Buyers once there give emphasis for selecting the best quality and mature bamboo which is mostly less available in market centers or roadside.

The second market transaction takes place after processing. It is between processors and value added consumers mainly at the center of processing or workshops. Only a few processors report that they have separate workshop and selling place. Further transactions in processed or raw bamboo take place, for example there is culm export to Sudan and Egypt, but overall volume become thinner and thinner and transactions are less frequent. Processors disclose that transactions are mainly takes place by negotiation and buyers have no higher leverage on producers or processors to enforce non-negotiated price.

7.2.3 Value Chain Strength and Patterns of Relationship

The bamboo value chain from Awi is found to be relatively longer and more complex, following several forms and routes than bamboo originating from other areas of the country. Existing production and trade for bamboo and value added products originating from Awi follows the following general pattern: (i) culms are processed by farmers or by microenterprises in Ingebara for sale at the roadside or in the local market; (ii) raw culms are transported by traders to Addis Ababa and Bahir Dar to be processed by microenterprises, used for the construction of tourist houses or exported to Sudan via formal and informal channel; (iii) farmers produce traditional value-added products in Awi and transport the products themselves to Addis Ababa, Bahir Dar, Gondar and Mekele, Nekemt, Harar, and other cities to be purchased by traders and tourists; (vi) processors (craftsmen) from Awi travel to the above places to produce value-added products and sell them in a place where they temporarily reside, and then continue moving, following market demand; (v) processors from Awi are invited by urban bamboo product traders to cities and are paid on the basis of the number and type of value-added products they have produced (Endalamaw et al. 2013).

Similarly, the Sidama has also authentic bamboo utilization tradition for house construction. However, the Sidamas used to utilize majority of the resource by themselves. However, it is reported that there is increased attention recently in bamboo trade and processing where farmers are being involve in the entire value chain especially in relation to house construction in the following: (i) raw bamboo culms, low-grade mats, basketry, and handicraft products were processed in rural Sidama and bought by traders and consumers and transported to Hawassa, Addis Ababa, and other nearby cities; (ii) skilled farmers who design and construct Sidama houses travel to construction centers to assist constructors with selection of quality culms, construction of houses, and traditional insect pest treatment; (iii) private and organized bamboo processing associations producing bamboo furniture and craft products in Hawassa and Hula

were dependent exclusively on Sidama bamboo and sold their products to consumers in the respective towns (Endalamaw et al. 2013).

Thus, the Awi and Sidama farmers are involved in production, processing, trade, and technology transfer from rural to urban areas. The relationships and structures of the value chains originating in the two regions are similar and presented in figure 7.1.

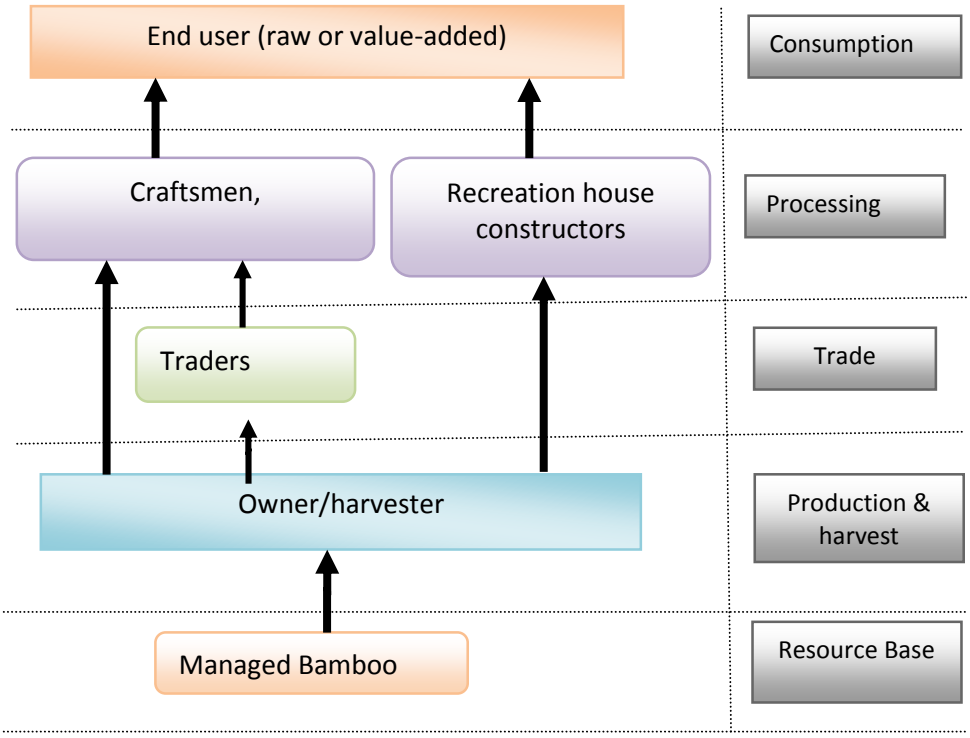

Figure 7.1: Typical value chain structure from Awi and Sidama (source: Endalamaw et al., 2013).

Sheka has the shortest value chain relationship of all regions (figure 7.2). Most of the bamboo collectors are farmers who consume the majority of the collection for themselves. The survey shows that from the culms entered to the market, over 53% are farmer to farmer transaction and the remaining is destined to local markets and in occasional cases transported to Gambella region for refuge house or smuggled to Sudan. The longest chain relationship identified in Sheka is when a firm bought culms from collectors at roadsides to process them into furniture, which is sold to Masha city dwellers. In all the transactions in Sheka, prices are fixed by buyers, a major difference from Awi and Sidama.

It is revealed that the major governance tool in the chains is market where most of the transactions were held through negotiation (Table 7.2). However, exceptions are also noticed. In Masha, the buyers have more power since there is no sufficient competition. Buyers have another advantage here: they order collectors to pile culms at the road side before the transaction date and collectors will be forced to accept the price fixed by buyers justifying that it is better than losing the whole. There are also situations where buyers order collectors to collect but fail to appear according to agreements. Collectors have no mechanism and power to force buyers to abide by their agreements. In Awi, most buyers are native to the region and negotiate with bamboo owners. Similarly, Sidama bamboo owners are not subjected to exploitation by buyers. They negotiate price with buyers or in the presence of broker. Craft processors from Addis reported that buying from Sidama is exploitative for them as brokers exercise excessive power stemmed from nativeness and often avoid buying from there. Another problem in the value chain reported by most of the processers in Addis Ababa is the bureaucratic hassles especially in the transportation activity. Transporters of bamboo are required to pay taxes at every check point and payment scale is often less transparent.

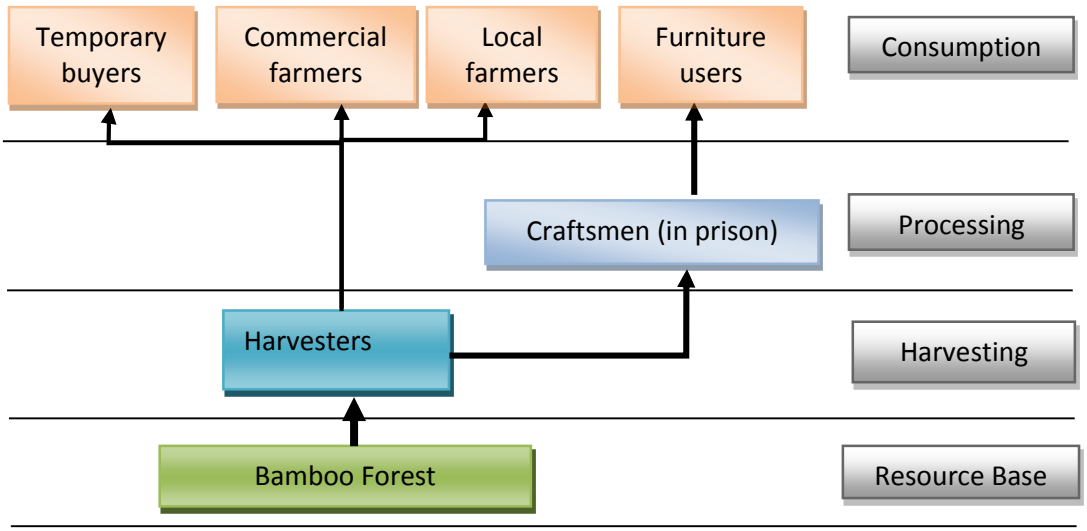

Figure 7.2: Typical value chain structure from Sheka (source: Endalamaw et al., 2013).

The value chain analysis about the structure and function of bamboo chain actors show that there is largely a direct producer-consumer relationship excluding intermediate actors. This feature is similar with wild spice value chain (Meaton et al. 2013) and medicinal product trade (Booker et al. 2012), both of which are less domesticated and commercialized products. Low value addition and limited demand for low quality bamboo products have attributed for this weak value chain network. The price of value-added products is found as small and is a mere summation of farm-gate price, labor and transportation costs

(see section 7.2.4). Processors reveal that higher prices, which lead to a higher cost for the consumer, may lead to the substitution of bamboo with other products as most consumers choose bamboo mainly for its cheap price. Thus, there are fewer opportunities to accommodate a large number of culm traders or brokers under the current level of consumer demand for bamboo products. In response to the low return and unstable demand and supply features, the bamboo trade is conducted in combination with other businesses and is often used as a stepping stone to move to other sectors. These tendencies reduce the commercial development of the sector, in agreement with the analysis of Braun and Kennedy (1994), who explain that commercialization is the outcome of profit-based decision making behavior by the various actors in the value chain.

Table 7.2: Summary of the Value chain system and actors relationship.

Features	Sheka	Awi and Sidama
Producer level processes and characteristics	Harvesters often does not own the bamboo forest resource	Harvesters are owner of bamboo resource
	Harvest from forest	Harvest from plantation& AF
	Short, simple and little market linkage	Relatively longer, complex and reach to the capital city and times to neighboring country
	Collectors have limited alternative livelihood	Bamboo ownership is not wealth dependents
	Majority collected for own consumption	More than two/third for market
Non-farming Actors	No trader, few government & NGO involvement and one processor	Traders, processors, NGOs and government are involved to extent
Transport	Shared by Harvester & consumers	Producer, trader, processor, consumers
Governance	Market, constrained by power asymmetry resulted by poor competition	Variable, in Sidama brokers exercise hegemonic power, in Awi no visible single power holder
Market availability	Ephemeral	Adequate and regular market availability reported in both regions

7.2.4 Revenue Distribution along the Value Chain

Based on the data from household interview, the average labor invested in bamboo management is two man-day per year in Awi and Sidama while nearly zero in Sheka. Since the selected enterprises do not obtain culms from Masha, the data from the managed areas will be used in profit analysis. Therefore, taking the opportunity cost of daily labor in the regions, the total cost per household per hectare is 400 birr which is 22 cents per culm. Selection and harvesting of a culm cost 40 cents while land value is 20 cents (Annex 10.8). The total average cost is 0.82 Birr. The average sale price in the two regions is 9 birr per pole (See section 7.3).

Traders buy bamboo poles at 9 birr and sale on an average price of 18 birr in Addis Ababa. They incur costs for transportation, loading and unloading, taxes and miscellaneous expenses at check points and yard rents and administration costs. Therefore, the net revenue per culm is 5.9 birr.

Processors buy from traders and produce a variety of products using a number of intermediate inputs and employed labor. Among the products, sofa is the most frequently produced and traded product. It is selected for analysis. For this purpose, detailed activities and cost drivers are documented for sofa set production based on the case study craft enterprises. The total cost of sofa production is 1975 birr. A sofa is sold for an average price of 3000birr. Net revenue per sofa chair is found 1025 birr, which is equivalent to 41birr/culm. This shows that quit a substantial amount of value is added at the processing level.

Thus, applying the average price data from survey of producers, processors and consumers and detail prices of intermediate inputs from the case studies and traders a profit distribution analysis is made for sofa production. The result shows that the percent profit margin for traders selling bamboo culms for sofa production is 32.7 and 34.17 for sofa producer enterprises. Details of the activities, cost drivers and revenues are presented in annex 10.8.

7.3 Producers' Income and Extent of Commercialization

Proportion of cash income is one of the indicators of the extent of commercialization of a product at production stage. Despite it does not indicate the level of value addition and extent of technology employed; it provides a clear indication of the proportion of production destined to market relative to subsistence consumption by the producers.

The survey result shows that average annual total income a household obtain from bamboo is 1534 birr (exchange rate during data collection was 1 birr= $ 0.0572), of which 834 birr obtained in subsistence form and the remaining in cash. Disaggregated by regions, Sidama household earns the highest average income of 2235 birr, followed by Awi with 2084 birr while Sheka with 284 birr (figure 7.3). Despite Sidama produce more culms and obtained higher total income, the cash income of Awi households is found the highest of all the three regions. The survey further shows that of the total income, only 37.41% is obtained in cash. However, regional differences are significant, reaching 60% in Awi and less than 10% in Masha. Moreover, of the traded volume, a good part of the trade is farmer-to-farmer; where about 20% from Sidama and 60% from Sheka ended with farmer-to-farmer transaction in trade and barter. In volume terms, about 38 percent of the bamboo trade takes place among farmers.

In Awi, where there is a well-developed road and large number of tourists pass over this region, a relatively modest demand and encouraging market price is reported for bamboo and bamboo products. As a result, farmers sell larger proportion of their bamboo culms and obtain a relatively a large share of bamboo income in the form of cash (Figure 7.3). Moreover, bamboo is found the prime cash crop in this region. In contrast to Awi, Sheka farmers earn majority of the bamboo income, which is smaller than that of the other two locales, in the form of subsistence. Despite relatively high total production in Sidama, cash income proportion is lower than in Awi. This difference is due to the high household consumption by producer-farmers in Sidama, which reduces the amount supplied to the market (Figure 7.3). Moreover, the price of culms is slightly lower in Sidama than in Awi probably due to a relatively lower quality road connection to the bamboo areas of Sidama compared to Awi.

In order to test statistically test income differences among regions a Kruskal-Wallis test was done and the resout show that income varied among households from a minimum in Sheka to a maximum in Sidama. Both total and cash income of Sheka farmers were significantly different from those of Sidama and Awi farmers at 95% confidence. However, there was no difference between Sidamo and Awi (Table 7.3).

In order to visualize the extent of bamboo sale frequency over the years, respondents are interviewed if they had sold bamboo products during the survey year. The result shows that 76% of the interviewees from Awi, 70% from Sidama, and 10% from Awi have sold bamboo products to various (Figure 7.4). Some of the reasons mentioned are: have no mature bamboo during this year, deliberately retain to get good price and no buyers visited us. Figure 7.3 further shows that there is no major difference among the three regions in terms of numbers of households using bamboo for subsistence purpose.

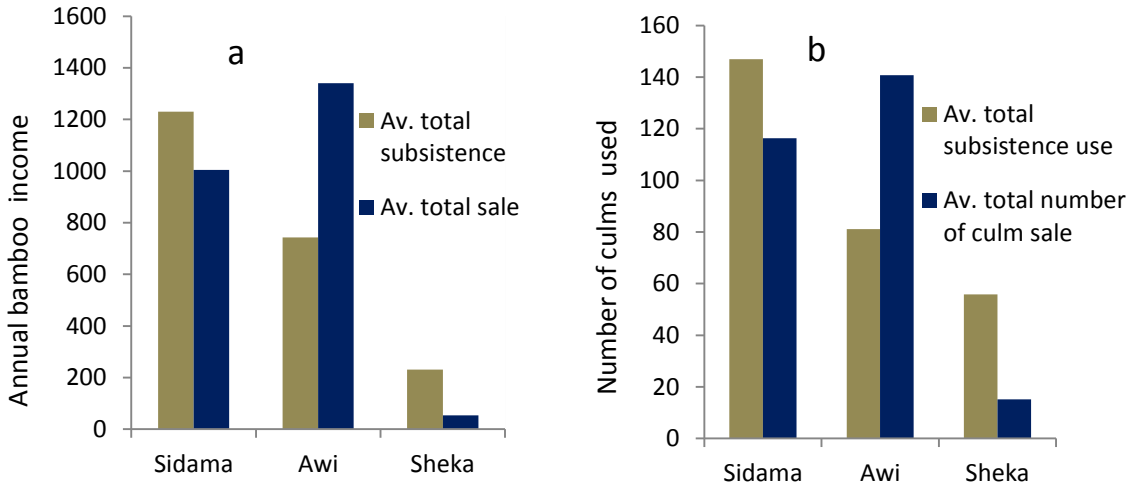

Figure 7.3: (a) Average total cash and subsistence income in birr and (b) number of culms used for subsistence and sale, disaggregated by region (Source: Endalamaw et al., 2013).

Table 7.3: Variation in total bamboo consumption (in birr) and degree of commercialization among three Ethiopian study regions (Source: Endalamaw et al., 2013).

Variables*	Sidama (n = 43)			Awi (n = 38)			Sheka (n = 52)			Kruskal test	
	Median	25%	75%	Median	25%	75%	Median	25%	75%		
Cash income	50	19	67	69	35	84	0	0	0	ANOVA ranks	H = 45.56 p < 0.001
	A			*A*			*B*			*Dunn's multiple comparison*	p < 0.05
Total annual income	200	100	400	200	87.5	400	50	30	80	ANOVA ranks	H = 29.95 p < 0.001
	A			*A*			*B*			*Dunn's multiple comparison*	p < 0.05
Price per pole	8	7	10	10	8	11	4	3	5	ANOVA ranks	H = 86.75 p < 0.001
	A			*A*			*B*			*Dunn's multiple comparison*	p < 0.05

** A = Sidama and Awi; B = Sheka*

An analysis of cash income within Sheka in relation to other livelihood sources reveals that it is the least commercialized product compared with cereal crops (14.1%), honey (85.4%), and spices (81%), where figures represent proportions of income obtained in cash. While the remoteness has visible impacts in other products except honey, the bamboo income is even lower probably due to low demand in addition to infrastructural factors (Table 7.4). Consequently, the average total cash income of households is higher than the average cash income from bamboo. On the other hand, the total value of cash income in Sheka

is only slightly higher than the income from bamboo sale in Awi. Obviously, no tree species including bamboo is mentioned as important sources of cash income in this district.

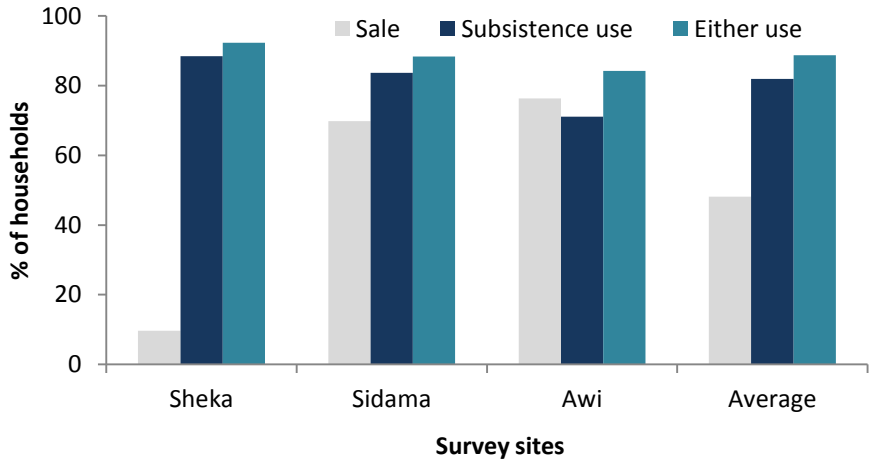

Figure 7.4: Percentage of annual bamboo utilization by households in three districts (Source: Endalamaw et al., 2013).

Table 7.4: Percentage of annual bamboo utilization by households in Sheka district.

Cash Income sources	Value in Birr	Cash income (%)	Major cash sources
Crop & vegetables	381.23	14,10	Cabbage, potato, Enset products, other crops
Livestock	459.56	34.52	Sale of cattle, butter
Honey	406.8	85.41	Unprocessed and partially processed
Spices	62.11	81.18	long pepper and cardamom
Bamboo	53.27	9.45	Culm sale
Other income	92.6	100	Carpentry, remittance, labor to other farmer
Total	1455.57	100	

Cash income contribution of bamboo has a wider range being the lowest in Sheka and largest in Awi, with an average commercialization ratio of a little higher than a third of total volume used. This shows that bamboo is less commercialized compared with other regions or products: for instance 93% for bamboo from Guanxi, China (Hogarth and Belcher 2013), 51% for *Adansonia digitata* fruit products from Sudan (Adam and Pettenella 2013) and even lower than that reported for forest products from southeastern Ethiopia (Tesfaye et al. 2010). The result from Sheka further implies that the limited market integration resulting from remoteness and poor road conditions combined with other socioeconomic factors have led to reduced cash incomes and reduced overall contribution of bamboo to households in Sheka. On the

other hand, a relatively higher engagement in value addition practices in Awi might have contributed to further the differences. Therefore, limited value addition practices and subsequent scarcity of market for raw or processed bamboo products not only keep cash earnings low but also found to reduce total income from the sector.

7.4 Determinants of commercialization

Commercialization is affected by a number of macro and micro-level factors at the production or the processing and consumption stages. Result of a regression analysis shows that the degree of commercialization which is expressed by the proportion of commercial income shows a significant and negative correlation with market distance and a significant positive relationship with type of management and labor invested for management (Table 7.5). Of this variables market distance has the highest explanatory power. Other variables such as age, education, family size, distance to road, gender are excluded since they are not correlated with degree of commercialization.

Table 7.5: Factors significantly affecting bamboo commercialization in three Ethiopian sites ($p < 0.05$).

$R^2 = 0.39$				
Variable	Coefficient	Standard error	t	p
Constant	−294.2	121.72	−2.42	0.017
Distance to market	−0.84	0.23	−3.02	0.003
Management labor	3.94	1.51	2.6	0.01
Management type	446.416	158.37	2.82	0.006

Source: (Endalamaw et al. 2013).

Another regression analysis specifically for each site is made to identify site specific factors and to know if there are differences in the extent of influence by the factors. The results show that there is no another influential factors for Awi and Sidama identified. However, in Sheka education level, family size and training attendance are found to positively and significantly affect commercialization (Table 7.6).

Table 7.6: Factors significantly affecting bamboo commercialization in Sheka ($p < 0.05$).

$R^2 = 0.29$				
Variable	Coefficient	Standard error	t	p
Constant	−39.06	17.44	−2.24	0.03
Education	2.55	1.27	2.01	0.05
Family size	5.11	2.0	2.55	0.014
Training	99.2	25.7	3.86	0.001

Source: (Endalamaw et al. 2013).

Group discussants in Sheka report that transportation is their major bottleneck that deters commercialization of their agricultural produce in general and believes bamboo is not an exception. Moreover, market and market information is also mentioned where they think that they have no aduqate modern communication media such as telephone that connects them with cities. One informant said that "we are far from government and far from civilization" (referring the cities). In a similar line of argument, interviews with processors in Addis Ababa and Hawassa reveal that despite ample resources in Sheka, it is not listed as a source of raw material by any of the interviewees. Their reason for not choosing Sheka as a raw material source was its remoteness and poor road conditions. It is reported that transporting of culms from Sheka to Addis Ababa costs nearly a culm price in Addis Ababa, despite the fact that bamboo is a freely accessible resource. The study further reveals that regional towns in southwest Ethiopia are not only small with limited service facilities and demand for bamboo resources, but they prefer to use and have relatively ample tropical hardwood timber for construction and furniture.

In contrast, bamboo originating from Awi and Sidama have a relatively adquate market opportunities. The bamboo production area of Sidama is located at about 140 km distance from Hawassa, a flourishing tourist and service town with an increasing demand for bamboo to construct recreational houses and furnishing them with bamboo furniture. Similarly, Awi has three nearby cities and towns like Ingibara, Debremarkos and Bahirdar with 5km, 80km and 125km from the major bamboo resource area respectively. Both areas have also standard road access to the city of Addis Ababa, the biggest city of Ethiopia. More than 50% of bamboo processing micro and family enterprises as well as the only remaining pioneer medium size bamboo manufacturing enterprise are located in Addis Ababa. Thus, the presence of a tourist destination, high service-providing cities of Hawassa and Bahir Dar, complemented by a good-quality road network connecting the two cities to Addis Ababa, the capital, has increased the demand for bamboo and bamboo products in Sidama and Awi compared with Masha with little urban functions and transportation infrastructure. This finding agrees with earlier studies where cities and associated urban functions stimulate product and service commercialization (Nepal and Thapa, 2009; Tadesse, 2012). Moreover, distance to market is the most pronounced factor for products with high weight-price ratios and perishable products. Thus, total culm price, which is a function of raw material and associated transportation costs to processing cities, has a direct influence on the choice of raw material source by bamboo-processing enterprises. It is observed in Chinese bamboo processing chain that, semi-process bamboo culms at production area and transport the most valuable parts is often practiced as cost reduction function. The results reveal that management intensity is positively correlated with the degree of commercialization.

The other factor that contributes to the disparities is the absence of bamboo technology development training and extension. Farmers from Awi and Sidama are frequent participants in capacity building trainings by FeMSEDA, whereas no training has been provided for Sheka farmers. NGOs and parastatal bamboo development projects have been operating recently in the country, but only one NGO has incorporated Sheka in its project. This NGO has offered training specifically in bamboo conservation and not in bamboo commercialization. This example demonstrates unequal access to technical training and market information among the districts. Therefore, access to knowledge and exposure to information at regional level and educational attainment among households might be another factors affecting commercialization. This is in agreement with a study comparing bamboo-growing villages in a remote region of China (Hogarth 2013).

7.5 Analysis of Opportunities and Challenges of Commercialization

It is discussed that commercialization is expressed in terms of market integration from input levels to a series of value additions and transactions along the value chain. Thus, the factors contributing for/against commercialization are analyzed based on the three districts. However, looking at a broader scale, for instance nationally, bamboo is still an under-commercialized and under-utilized species. It is not attracting large scale industrialists and large areas of the bamboo resource area are still dying without being utilized. The general national features are analyzed based on expert interviews, case studies and group discussions with craft enterprises. Analysis is made based on key commercialization determinant concepts along the value chain from the resource development to processing and marketing.

Resource condition

The bamboo resource of the country is generally large estimated at about 1 million hectares. However, experts question the accuracy of the data and presence of up-to-date data. Even though resource size is likely is lower than this figure, it is still an adequate resource on which to build a competitive bamboo based industry. The opportunities are that the resource can be reached for industrial utilization in 4-6 years and there are large ecologically suitable areas for bamboo expansion as small or large scale plantations. The native species fulfills many of the criteria for industrial utilization. Moreover, the commercially important resource of China (*Phyllostachys edulis*) is thriving in the highland areas of Ethiopia. The risk is the natural death of the resource, which cannot be predicted with certainty. Moreover, the long term impact of the introduced species, should they be promoted as an alternative to existing native resources, is not known. The threat is depletion of bamboo forest for expansion of small

and large scale agriculture. The smuggling of raw bamboo to Sudan without value addition is another threat that could reduce the supply potential for industrial utilization.

Preprocessing and processing technology

Bamboo is sensitive to moisture contact. Together with its inherent sugary nature which attracts insects and pests, the storage of bamboo in moist places and without aeration often causes damage. While many of the processor craftsmen and enterprise owners are aware of it, most of them do not give enough emphasis to preservation of their raw material and value added products. Moreover, they have less access to modern treatment packages and are hindered by space limitations for proper drying and aeration. Therefore, there is a higher risk in the durability of products made than that reported by the experts and the consumers interviewed. Subsequently, there could be a danger that the products may remain inferior as long as they are not protected from pests, even if a substantial portion of the society starts to use bamboo products.

It is reported that a research project is being undertaken to improve pest problems by the forestry research center of Ethiopia. Moreover, as reported in the previous chapter, there is indigenous treatment knowledge that could be applied at every stage from plantation to consumption. There are also internationally available treatments applicable by SMEs (Liese and Kumar 2003; Liese 2005). The structural properties of the bamboo varieties are also tested and positive results have been reported (Kelemework et al. 2008; Boeck 2014; Schmidt 2013).

Processings are done using low quality hand tools with a few machines. The introduced machines used by the medium enterprise are originally designed for Moso and have a high wastage rate. They are also unaffordable to most of the bamboo processors in Ethiopia. One of the experts discloses that the wastage rate in Ethiopia is about 80%.

Market pattern and demand

In Ethiopia, bamboo still has low image and those elites and foreigners who are familiar with and have interest in bamboo are often discouraged by poor quality and pest- susceptible products. Bamboo processors have low capacity to identify needs and requirements so as to respond according to the market demand. Furthermore, its international competitiveness is also hampered by low quality products. Moreover, Ethiopia is a land locked country and transportation costs are high for accessing the international market. On the other hand, experts think that using authentic Ethiopian cultural products as

a model increases the authenticity of Ethiopian made products and can increase their competitiveness compared to familiar Asian brands. Several experts have iterated that productivity is too low compared to China and given the low efficiency rate and increasing raw material price, competitiveness in the international market will be unlikely at the present stage.

A number of tourist houses and recreational places are using bamboo houses, furniture or decorations. Experts highlight that recreation related demand is the major market for bamboo in Ethiopia. This market is growing along with the tourism industry and there is increased awareness of actors in the tourism sector for bamboo and its products. The threat is that Chinese or other mass producers may compete in the Ethiopian tourism market, though still the high transportation cost and the quest for authentic products in the tourism industry may restrict Chinese competitiveness.

Recently, the potential marketability of bamboo in the global market is becoming known by the craftsmen and the farmers. This together with the trainings provided, is expected to increase market awareness and also approaches to marketing. Moreover, the trainings and increasing product innovation may improve the image of bamboo and its products in the local and global markets. The majority of the interviewed enterprises reported that prices for bamboo culm and value added products are increasing.

Policy and institutional innovations

It is reported that institutional and policy changes in the forestry sector directly affect the processes of bamboo sector development and commercialization. Over the years, the forestry sector changed from command and control system of conservation to a near open access situation, with some emphasis on community based conservation and, finally, at least in two regions, parastatal enterprise establishments are accepted as major forest management approaches. The risk is that local communities might not accept the enterprise based arrangement since it is established by abolishing or downgrading the role of community based conservation organizations.

Climate change and carbon trade is another macro-level factor that may facilitate commercialization of the bamboo resource. Countries with bamboo resources are lobbing in climate change negotiations for bamboos recognition as a carbon sink. Recent INBAR strategic documents to apply bamboo as a mechanism to reduce the effect of climate change is a pertinent example that the commercial income of bamboo for communities could be increased (INBAR 2014).

Moreover, the recent thrust towards market oriented forest management may facilitate access to bamboo resources outside of farmers' land holdings and reduce bureaucratic obstacles at check points that lie behind a cover of forest conservation efforts. This in turn may increase entrepreneurial interest in the sector and lead to a further increase in innovation and commercialization of the resource.

7.6 Summary

The result presented in this chapter reveals that higher management intensity, integration in the value chain and presence of marketing and knowledge infrastructure results to a higher rate of commercialization and correspondingly higher cash and total income from bamboo. The study further reveals that proportion of commercial use of bamboo is roughly a third of total consumption. However, micro differences were evident, reaching up to 60% in Awi and only 9.48% in Sheka. Bamboo value chains originating from Awi and Sidama are found longer and denser than that from Sheka. Morover, bamboo producers from Awi and Sidama are vertically integrated in the value chain as they are involved in processing and trade. Thus, the analysis of the management intensity, value chain and cash income indicate the level of commercialization. The major factors significantly affecting differences in rate of commercialization among regions are access to market, extent of management intensity and specifically in Sheka, knowledge, market information and family size. The key challenges and opportunities in relation to resource, policy, technology and market related factors are also investigated.

8 Synthesis and Conclusion: Technology Sourcing, Innovation and Commercialization

8.1 Introduction

In the previous chapters, traditional technologies, innovations and determinants of innovative commercialization are discussed. Moreover, it is argued that although commercialization as a literal concept refers to the integration of a product in a market economy, the process entails building of a system of learning, production of innovative value added products and securing a market for the products. However, the innovation processes, particularly in Africa, has been largely preoccupied by a narrower aspect of innovation system, i.e., technology transfer and adoption (Ayinde et al. 2014). Moreover, the importance of technological innovation is more pronounced in the case of bamboo than in other agricultural products such as coffee or honey which can be consumed without major value addition. In contrast, bamboo, due to its nature and consumption pattern, requires substantial value addition since raw material trade alone may not lead to successful commercialization. Therefore, the commercialization of bamboo requires the building of a system of innovation and dynamic value chain to improve production, processing and marketing of internationally competitive bamboo products. As a result, the thesis applied the SI and Value chain approach as theoretical lenses to analyze options for commercialization.

This chapter discusses the key issues investigated using the theory as a focusing device. The issues are technology sources, value chain and innovation interactions, entrepreneurial innovations, institutional supports and challenges of innovative commercialization for the bamboo sector of Ethiopia. The summary of the synthesis presented as a model in table 8.3.

8.2 Sources of knowledge and Technologies

8.2.1 Local Technology Sources for Innovation

Local innovations create technological and organizational knowledge that is instrumental in building competency which is increasingly recognized as the element responsible for technological take off and catch up (Wamae 2013; Kim 1999; Djeflat 2013; Cohen and Levinthal 1990). As a result, increased recognition is given to indigenous technologies and knowledge as a basis for innovation. The empirical data reveals that there is a diversity of bamboo knowledge and technology owned and appropriated by farming households and urban crafters mainly in bamboo growing regions and adjacent cities and towns. The knowledge ranges from resource classification to management and systematic exploitation.

Informants have also skills in the making of over 26 different traditional bamboo products. However, the result shows that knowledge is not distributed equally in the study regions and among households within the study regions. Communities in Sidama and Awi have developed their traditional knowledge and gradually turning to semi-modern products. These communities are characterized by a better exposure to external knowledge and skill through experience sharing. They are also better connected with urban functions; earn better income and sell a majority of their total bamboo harvest.

Products produced based on local knowledge and skills are of low quality and the production is still manual with the exception of semi-automated processing tools. As a result the products are inferior compared to comparable bamboo products in the international markets. Despite these limitations, it is still one of the major sources of knowledge for farmers and craft enterprises.

On the other hand, the innovations in the recreational house industry being carried out by blending traditional design and modern reinforcement approaches has brought about a promising result (see chapter four). It is becoming a competitive approach for building, furnishing and decorating recreational houses. While the housing technologies are dispersed across the country, the technologies from South-central Ethiopia have more access to the urban market than those from the other regions. The houses are reported as aesthetically beautiful and structurally stable. Therefore, combining the traditional techniques with modern design technologies serves for further innovation within the sector. Similar studies for example from India show that indigenous technical knowledge stimulates grass roots innovation and is equally important for advancing conventional innovations (Borthakur and Singh 2012; Gupta 2006).

While the indigenous bamboo technologies are thriving and supporting the growing craft and construction industry, the study found that there is little augmentation resulting from R&D. Although bamboo development efforts count decades in Ethiopia, the R&D aspect is much younger and other than consultancy papers, there were few research projects and scientific publications until recently. Moreover, experts in the field are scant. Similarly, the educational system of the country has not yet given attention for bamboo related education. There are no specialized bamboo studies and only as a part of a wood processing course that bamboo is included in any higher education curriculum. On the other hand countries which have successfully commercialized their bamboo resource such as China have a large number of bamboo research institutes, thousands of researchers and research coverage from tissue culture to high tech engineering specialized on bamboo. To mention a specific example, researchers in bamboo disease and pest control have studied the life cycle, prevention and control methods for 200

different insect pests attacking bamboo and more than 180 academic theses have been published on this specific topic alone (Zhaohua 2008). Similarly, processing technologies, supply chains and appropriate development and dissemination strategies are also well studied. In Ethiopia, in contrast, there is virtually no rigorous study of insect pests so far, despite the fact that it is the major problem in bamboo development. To a large extent, other aspects of bamboo related knowledge are also all at their infant stage.

8.2.2 Foreign Technology Sources of Innovation

Developing countries seeking technological change for productivity growth and global competitiveness develop national innovation systems based on either local knowledge or transferred technologies from abroad. Alternatively, they may choose to blend appropriate technologies both from indigenous and transferred technologies in a way that fits their setting. In the previous decades, technology transfer has generally been considered as a primary choice, if not as a panacea for developing countries. However, recent studies increasingly question the feasibility and adaptability of transferred technology. For instance, Fu and Gong (2011) argue, that if technologies were easy to diffuse and adapt, developing countries may easily imitate technologies and be able to catch up with developed countries. In reality it requires a local system that is capable of identifying appropriate technology and absorbing it (Altenburg 2009). It also requires time, effort and training to assimilate and internalize the transferred technology (Cohen and Levinthal 1990; Douthwaite et al. 2001; Lin 2003). Another factor inhibiting adoption of foreign technologies is the large tacit component (Kessler et al. 2000) and possible sticky ness (Szulanski 1996).

Despite these lists of limitations that show that technology transfer is not an easy option; in a country like Ethiopia where the indigenous technologies are not sufficient and are not supported by R&D to transform the traditional bamboo products into competitive global product, the need for technology transfer is inevitable. Thus, there is a need to supplement local technologies with external sources of knowledge and technology. To facilitate the process, the government of Ethiopian issued a science, technology and innovation policy taking technology transfer as a priority for building national capability for technological learning and developing independent innovation (MOST 2012). Moreover, studies show that not all technologies and all sources are equally difficult to adopt. As such, technologies that are less radical, are from a relatively familiar culture and which are in immediate demand can more likely be learned and adapted (Douthwaite, 2002).

The craftsmen in Addis Ababa reported that they use craft designs from abroad, mainly from Asia, and adopt them to their own demand and production conditions. For over a quarter of them, it is reported as their prime source of knowledge and design blue prints to advance their craft innovation. Moreover, it is found that craftsmen in Addis are found more willing and capable to adopt foreign technologies than similar counterparts in the rural areas and rural cities. This probably is due to their relative exposure to foreign technologies and increased demand for quality and new products from their elite customers. However, as described above, technologies have a tacit component and hence it is less likely that technologies coded in products and seen in the web may be imitated in their entirety. Therefore, it is likely that they observe the external appearance of foreign products as a blue print to produce a product of their own or improve existing products by combining knowledge and experience gained from local sources and these foreign technologies coded in the product. Thus, this is more of a process of technology learning and innovation than mere imitation.

In addition to craft technologies, attempts are underway on bamboo charcoal introduction and adoption. This process is handled by INBAR and the government. The intention is to produce high grade briquettes to export high quality bamboo charcoal to the European market. The extent of adoption is yet to be seen as it is not up-scaled beyond the pilot areas. However, outside of this project, Adal enterprise has already started the production in export standard and has been exporting to different countries. Therefore, it is clear that small scale technology transfer schemes are started by government, NGOs and private enterprises.

8.2.3 A Model of Technology Sources for Bamboo Innovation

The foregoing discussions show that the blending of indigenous and foreign technologies in a noble way provides a comprehensive model of knowledge sources for innovative commercialization of bamboo in Ethiopia. Synthesizing the results from the different interviews as well as literature sources such as (Bommer and Jalajas 2004; Massa and Testa 2008; Lee et al. 2010; Iammarino and McCann 2013), the main potential and existing sources of technology for bamboo innovation and commercialization in Ethiopia is summarized as shown in figure 8.1.

These sources include: bamboo traditional technologies, wood technologies, handloom technologies, local research and development, learning by interaction and transferred technologies. Thus, as described above, the first source of knowledge and technology is the traditional knowledge of rural bamboo producers and artisans. Its importance is also reported from other countries (Yu 2007; Borthakur and

Singh 2012). For instance, Yu (2007) highlights those traditional craftsmen in rural areas who offer a rich material knowledge and experience in bamboo production which is important for its industrialization (Yu 2007). He further noted that the mainstream bamboo utilization in the industrial system shares practices with traditional methods; such as preservation, preprocessing, and reconstructing culms to certain end products (Yu 2007). Therefore, both the empirical data and literature sources affirm that indigenous technologies are one of the prime resources for fostering bamboo innovation.

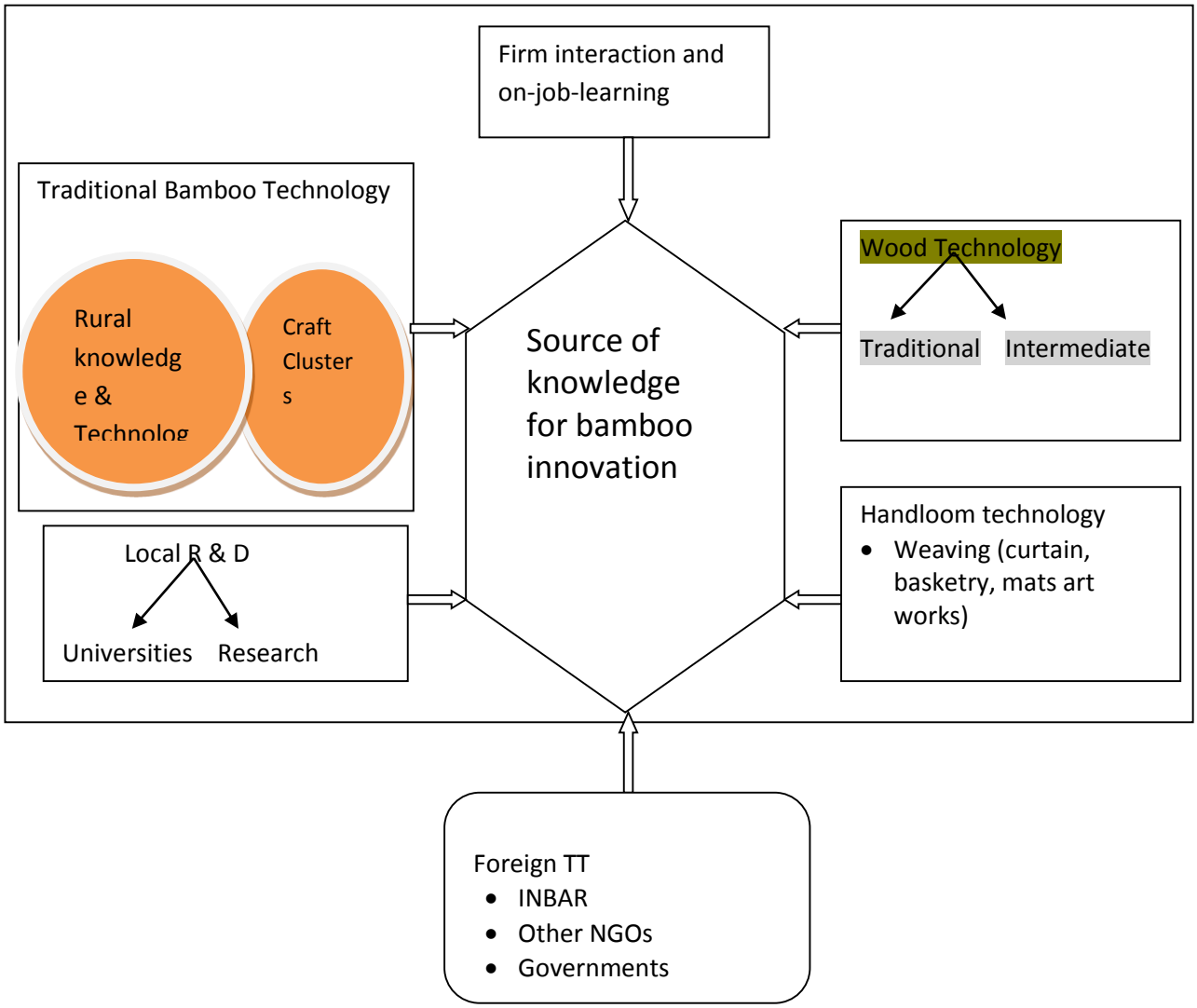

Figure 8.1: A model of source of knowledge and technology for bamboo innovation in Ethiopia (source: own elaboration).

It is found that wood technologies are the second source for bamboo innovation as the majority of the routine working technologies, designs and standardization for bamboo craftsmen are obtained from them. Even those technology developing centers such as FeMSEDA are using wood processing machinery to

produce a similar machine for bamboo processing. Similarly, the traditional handloom sector, where the country has strong and broad based skill, provides technologies adaptable to bamboo mat technology. It is found that in the Chencha area for instance farmers produce both the finest handloom and bamboo mats for furniture and house construction. Similarly, semi-modern enterprises are using handloom products to increase product attractiveness and subsequently demand for their bamboo sofas and stools. Therefore, there seems to be a transferability of skill from handloom to bamboo, especially for mat and basketry production. Moreover, the local research and development which can be a source of knowledge and technology by its own, is also crucial in building competency to advance existing local technologies and to enhance absorptive capacity and technology assimilation by firms and other actors (Borras and Edquist 2014; Muchie 2013; Morrison et al. 2008; Kim 1997; Kim 1999; Bell and Pavitt 1995; Dahlman et al. 1987; Katz 1987; Lall 1992, 2001 and several others). Finally, international technologies, particularly craft and construction technologies which are relatively easy to adopt, are already being transferred via internet by enterprises and trainings provided by government and international organizations. However, as argued above, its role will be successful when there is adequate absorptive capacity from indigenous firms or sectors (Cohen and Levinthal 1989; Fu 2008; Crespo and Fontoura 2007; Hervas-Oliver et al. 2012), extent of tacit component (Howells 1996), appropriateness and suitability to the recipient system (Douthwaite 2002; Driffield and Love 2003) and extent of linkage and interaction (Ivarsson and Alvstam 2010).

8.3 The Nature and Role of Value Chain

It has been already reported that the bamboo value chains are less strengthened and value chain relationships are weak and ephemeral. There are no viable brokers and traders that make relationships sustainable among buyers, processors and producers. The absence of this system reduces the participation of buyers in value chain development.

In relative terms, the bamboo value chain from Awi is found to be longer and more complex, following several forms and routes reaching more cities than bamboo originating from other areas of the country. It is also reported that bamboo culms are exported to Sudan via legal and illegal routes through the western border of the country. Moreover, farmer-processors and traders are found larger in number here than the other study regions. Despite these differences, the empirical results show that only a couple of truck-loads of bamboo per week are marketed from each region of Awi, Sidama and Gurage. This is insignificant compared to the estimated 3 million m^3 of harvestable annual volume in the country (Embaye 2003). Total average proportion of sale is found only about a third of total consumption but reaching

nearly two-third in Awi district. Sheka is dominantly characterized by farmers' consumption and local trade. Bamboo culms entering the processing stage are mainly processed by survival craft enterprises whose main customers are also poor urban dwellers. Only a small segment of the semi-modern enterprises have elite customers. Therefore it is a business with low value chain, poor processors and low-income consumers.

Despite existing bamboo value chain generating total income for processors and supplemental income for producers (see 5.7 & 7.3), it is not found a major source of knowledge for further upgrading bamboo production and processing. Contrary to this situation, studies show that value chains are a major source of innovation and upgrading (Morrison et al. 2008; Humphrey and Schmitz 2002; Pietrobelli and Rabellotti 2011; Farole and Winkler 2014b). Moreover, multinational enterprises (MNEs), such as IKEA (furnishing retailer), outsource design technology for suppliers and small processors in developing countries (Ivarsson and Alvstam 2010; Kaiser Associates Economic Development Partners 2014). In the process firms in developing country develop innovative capacity to produce their own unique products.

As described above (section 6.4.2), to raise a more or less regular and good quality supply, enterprise-farmer partnerships are being initiated. Early on, the Adal enterprise started to enter into agreements with the farmers which were not succeeded, and recently another partnership is in the making which is yet to be tested. This arrangement, if put into action, can upgrade the efficiency of the supply chain relationship and pave the way for more transparent flow of knowledge and experience along the value chain. According to the design as reported by the African bamboo experts, farmers can do preliminary processing to reduce transportation costs and farmers will get in return technological packages and training from the company. This arrangement is more or less similar with the famous company plus farmer strategy of China, the latter of which significantly improves supply chain efficiency and together with technological development increased the utilization rate from 20-30% to 85-100% (Zhaohua 2008). This is because the materials that were previously wasted became utilized by various actors along the value chain.

The empirical results further revealed that capacity, financial and business environmental factors hinder processors from producing quality products. This, in turn, reduces market demand and deters accelerated commercialization of the resource. Thus, for improving the quality standard, there is a need to improve the management and coordination of the whole value chain to achieve a considerable market share in the global market (van Lugt and Otten 2006). Integrating vertically with processors and marketers, product harvesters and producers can increase their knowledge on existing demand and its trend and thereby

increase their chance of producing innovative products (van Lugt and Otten 2006; Ivarsson and Alvstam 2010; Pietrobelli and Rabellotti 2011). Meanwhile, the interactions facilitate innovation production at production, processing and consumption levels.

8.4 Entrepreneurial Innovations

The sector has a small number but a large diversity of enterprise actors ranging from those who work temporarily, when they fail to get daily labor (the lowest livelihood option possible); those who prefer bamboo as better option than daily labor; those who engage in small profitable business and to those with industrial firm status. Consequently, as Smallbone et al. (2003) argue, interest for innovation and the type of innovation practices vary accordingly. Most survival enterprises and crafters engage in producing low quality products for low quality purposes and are willing to sell at the cheapest price. A study shows that competition through improved quality stimulates innovativeness while competition on price hinders the propensity of firms to innovate (Smallbone et al. 2003). To engage survival enterprises in innovative production, avoiding the various constraints ranging from economic to regulatory issues is reported as a remedy (Voeten and Naudé 2014).

It is highlighted that several semi-modern enterprises have produced incremental innovation, or are moving to semi-automated production technologies. State agencies demonstrate the use of better preservation techniques, production and use of a modified processing machine. Medium enterprises use Asian machines that are new in the Ethiopian context but established technologies in other regions. According to (Nelson 1993), innovation in firms encompasses the process of mastering product design and manufacturing processes which enhance their economic performance and are new to them if not to the universe. Moreover, for enterprises in developing countries, incremental innovations and systematic adoption of foreign technologies are adequate in the initial stages of technological development (Voeten and Naudé 2014; Szirmai et al. 2011) and an emphasis on technological breakthroughs is not a necessity (OCED 2013).

According to Wamae and Kraemer-Mbula (2010), the decision choice of technology use and upgrading of entrepreneurs is also influenced by the interaction and dynamics of demand and available technologies. Moreover, the creation of new technological opportunities (whether new to the firm or to the world), depends on the ability to learn, adapt and up-grade the technological capabilities of the specific enterprise to meet a specific demand (Wamae and Kraemer-Mbula 2010). Thus, the conditions of the demand and firm capability affect the course of engagement in technological and organizational innovations. The

presence of demanding consumers likely motivates entrepreneurs to improve their production quality. However, the study revealed that most of existing consumers of bamboo to a large extent are less demanding in terms of quality. Their interest for bamboo product is, in most cases, to fulfill short term, often low quality functions/utilities such as temporary refuge houses, low quality transitional furniture by newly established families or survival micro/family businesses. This is partly due to customers' belief that existing bamboo processors lack the capacity for producing quality products. This capability limitations coupled with external barriers also affects the potential of firms to identify, select and absorb appropriate technology and knowledge (Cohen and Levinthal 1990; Morrison et al. 2008; Farole and Winkler 2014b). Thus, there is an intricate relationship between demand and innovation as well as ability to absorb external technology and innovative capability.

8.5 Institutional Actors and Functions

Since innovation is the result of different levels and types of interactions, facilitating learning and capability upgrading of firms, establishing clusters and supporting user producer; the role of intermediaries is pervasive in building innovation system (Szogs et al. 2011; Lundvall 2009; Hoppe and Ozdenoren 2005; Howells 2006; Lall and Pietrobelli 2005; Lundvall et al. 2002). Moreover, intermediaries assist in promotion and formulation of innovation vision, continuous network formation and adaptation, and facilitation of multi-stakeholder interaction by means of network coordination and mediation (Klerkx et al. 2010; Klerkx and Leeuwis 2009; Kristjanson et al. 2009). In Ethiopia, particularly in the bamboo sector, the role of facilitation and knowledge development largely rests in the hands of NGOs and government agencies. As described in chapter six, NGOs organize trainings, provide seed many and equipments for craft and medium enterprises. They also support farmers in the management of resources and processing of value added products. However, only a small proportion of farmers and crafters who need training get the opportunity to attend. Trainee selection has also reported to have serious flaws where those with less interest for bamboo practice get the training at the expense of the needy ones. According to Kaufmann and Tödtling (2002), innovation support systems that do not target the most serious constraints or identifies a target firm which actually does not need help is called mistargeted support. Similarly, the provision of training that is not needed such as craft training for a farmer who has no interest in craft production is a mistargeted innovation support. Notwithstanding this assertion, the majority of craft processing trainings conducted in the country is mainly given for farmers. The total number of urban trainees who joined the craft business is relatively larger than those from rural areas. Though urban trainees surpass rural trainees in joining the business, probably due to presence of better market

opportunities, irrespective of location the majority of trainees did not join the business. On the other hand, existing bamboo crafters working with a limited traditional skill and are in need of training do not get the opportunity since in most cases they do not have legally recognized addresses or are not registered enterprises.

Moreover, supports are reported as unsustainable. Furthermore, there is little follow up and encouragement to apply the knowledge and skill provided as most of the training supports are often project based and expire before the trainees are fully engaged in the business. Therefore, trainings have limitation in coverage, selection of participants and ensuring sustainability. In spite of these limitations, NGOs are one of the major intermediary organizations linking innovation actors and working towards the development of bamboo sector innovation and commercialization.

Government has also more or less overlapping role with NGOs and sometimes works in collaboration. The government is also working with INBAR (inter-governmental organization largely constituted by countries of the south). This network is contributing TT. In addition to supporting capacity development, it is institutionalizing technology development efforts. Towards this goal, it has started establishing technology producing and extension agencies such as the FeMSEDA and TVETs. These organizations are intended to produce technologies and disseminate them among users. It has established a science and technology ministry, largely taking experiences of China and other Asian countries. The ministry is undergoing organizational changes to accommodate the need for successful technology transfer and development of local knowledge. However, the experts in the ministry reports that there are acute shortage of manpower and higher attrition rate of employees (Annex 10.7). Thus, the ministry is yet to organize itself to have a better capacity to facilitate the technology transformation as outlined in the policy document. It is also supposed to link the government, businesses, farmers and academics.

Thus, NGOs and the government are more or less playing intermediary roles for knowledge dissemination and innovation development (See 6.5). This is a role similar to that reported by Szogs et al. (2011) for Tanzania and El Salvador. They are particularly vital in a value chain of this type where actors are poorly networked and there is a need for innovation brokers (Swaans et al. 2014). Furthermore, studies report that facilitation of interaction and improvement of the learning capabilities of a firm are important goals of public intervention in the field of technological change (Heijs 2012; Lundvall and Lorenz 2011).

8.6 Challenges and Opportunities for Innovative Commercialization

8.6.1 Introduction

Entrepreneurs often join a business after making a SWOT (Strength, Weakness, Opportunity and Threat) analysis about the feasibility of a business sector. If they found opportunity especially from the resource and market availability point of view, they often accept competition as a factor they could overcome through innovation. In the previous chapters, the business situation of bamboo presented in various forms including through SWOT analysis and this subsection discusses the implications of the main barriers for the innovation process and overall commercialization of bamboo in Ethiopia. Knowledge and capability constraints are not described here since enough emphasis is already given in the earlier sections.

8.6.2 Resource Size and Distribution

The resource condition and its commercial viability have been questioned by a majority of the experts and large enterprises interviewed. Although existing figures put the bamboo resource at around 1million hectares, the majority of the professional expert interviewees believed it is an exaggerated figure and argue that rigorous bamboo resource assessment surveys have not been made until recently. Moreover, since the majority of the resource is in forest form and deforestation is still unchecked, figures reported a decade ago may not be a viable estimate for current investment analysis. It is also reported that inaccessibility and most importantly remoteness of source of raw materials increases transportation and other costs for crafters. Thus, resource supply sustainability is still a challenge and is essential to avoid risks associated with low quality, lack of uniformity and unreliable supply as reported by Leakey and van Damme (2014) for agroforestry product value chains.

On the other hand, bamboo can reach commercial harvest in 4-6 years period in Ethiopia and the fact that a large area of the country is suitable for bamboo plantation development, dependence on natural bamboo forest is not the only option. Moreover, there is a favorable policy environment for forestry investment where investments are incentivized through lease free land, free from taxation until first harvest and capital goods import provisions if bamboo entrepreneurs or potential bamboo farmers wish to establish bamboo plantations.

Another policy related problem for bamboo resource utilization particularly mentioned by medium sized enterprise is the existing resource governance and regulation trend which equate bamboo harvest with the harvesting of any of the other forest tree resources. Though bamboo harvest especially from the forest ecosystem may affect other resources during harvesting disturbances, the exploitation of matured

bamboo unlike the other tree species can improve stand vigor. As such the harvesting of bamboo should be promoted as harvesting of grass species and should only be regulated, i.e. avoidance of juvenile harvest should have been put in place instead of stricter resource extraction control systems as is the case for tree harvesting.

8.6.3 Susceptibility to Pest and Disease

One of the major problems for wider application of bamboo is not the natural low quality of the raw material as is often presumed, but its vulnerability to insect and disease attacks. These are also reported as the root causes of the low value accrued to bamboo products. The study further showed that pests reduce quality and price, meaning that the crafter makes a low income and continues to produce similar types of product, see figure 8.2 for the nexus.

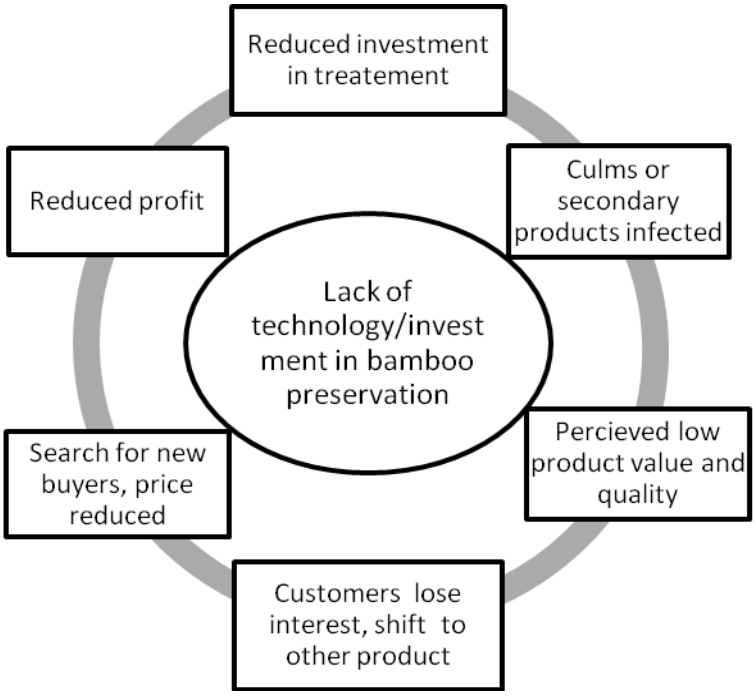

Figure 8.2: Vicious cycle of (absence of) bamboo preservation (Source: own elaboration).

8.6.4 Interaction and Knowledge Sharing

The interaction is highly restricted within a family groups and friends. There is little direct interaction and knowledge sharing especially among semi-modern enterprise owners. Only less than 10% reported that they discuss beyond their family firm, of which few discuss technological issues. Similar firms with a better social interaction and trust reported production of promising innovative products (Ng et al. 2012).

Interviews with the SME promotion agency and by some of the crafters themselves also show they fail to reach to an agreement to establish a viable cluster to deal with the government, the technology sources and regulating the market. While the majority of them believed in the requirements of this type of organization, they are less committed to work on its establishment and development. Their argument is that they could fail after they invest their time and resource. The study further showed that the enterprises compete largely by price manipulation than with investing in innovation. These are all against the requirements of a working innovation environment.

Similarly, vertical relationships within the value chain are weak and in most cases there is no permanent relationship between supplier, processor and consumer. The number of bamboo based intermediaries except government agencies is small and they often work part-time (Endalamaw et al. 2013). Processors do not see brokers as relevant. As a result, processors often-times escape them and directly buy from farmers. Moreover, the quality and maturity of the culms is not controlled when the transaction is made through a third party, which leads to a low quality value added product. Therefore, this system is also found to be an obstacle in the existing value chain governance arrangement.

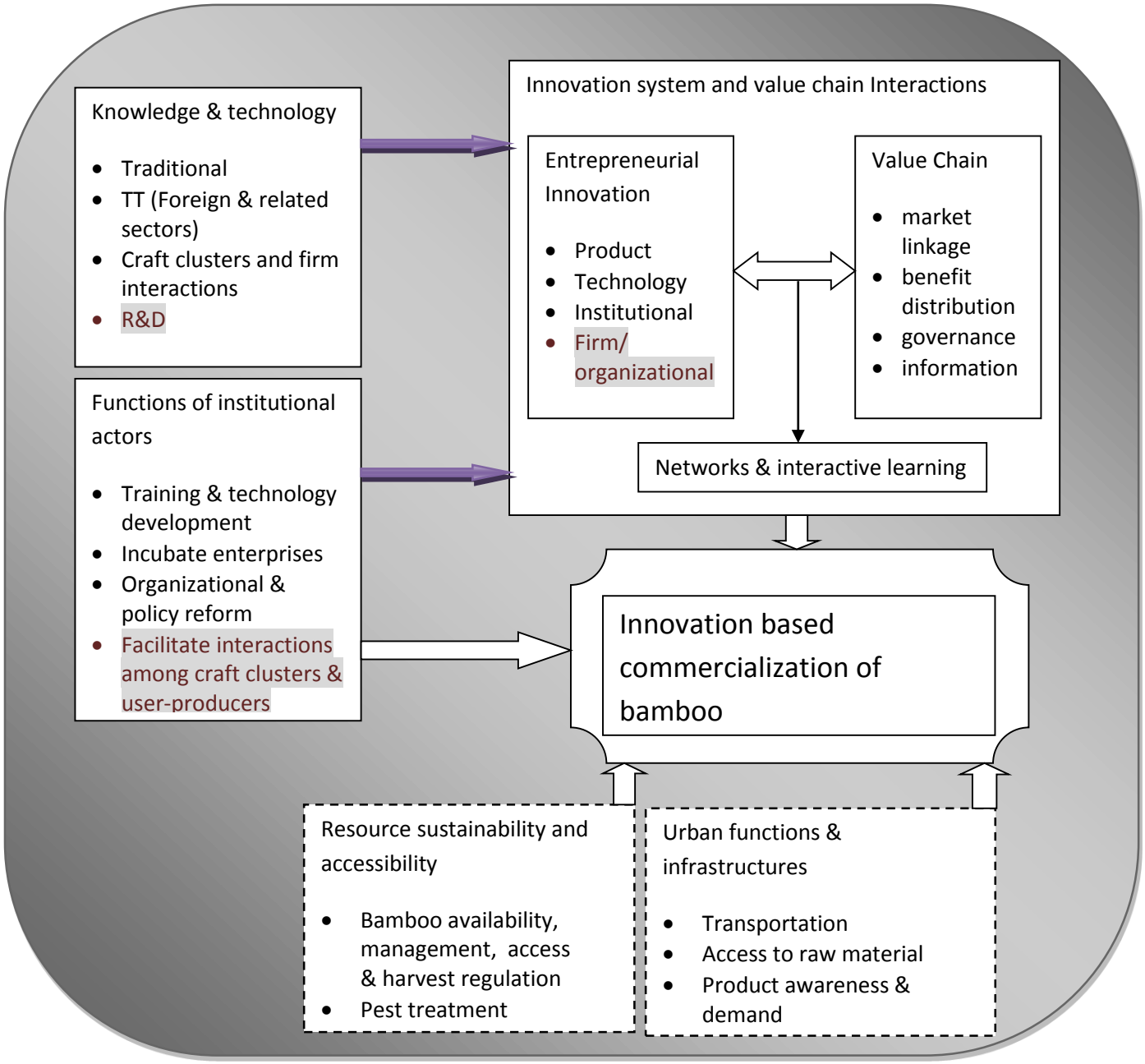

Figure 8.3: A conceptual model for analysis of innovation based commercialization of bamboo in Ethiopia.

Note: Issues in dashed boxes are only partially tackled while shaded concepts are hardly addressed since they are not yet fully existent in the system.

8.7 Reflection on Theory and Methodology

SI and value chain approaches are widely used theoretical approaches to analyze innovation and commercialization of resources and as intervention guide to transform the sector. Similarly the cluster

approach, although used as part of SI in this thesis, is another competitive theoretical tool. Scholars in innovation study argue that innovation and development in Africa can be achieved via building systems of innovation and technology (Muchie 2003; Muchie and Baskaran 2012; Lundvall 2009; Kuhlmann and Ordóñez 2015; Juma 2011). Proponents of cluster approach argue that cluster development in SMEs is a viable option for building systems of innovation and technology (Diyamett 2012; McCormick 2007; World Bank 2008). On the other hand, studies in value chain analysis underline that the development of (global) value chains can facilitate both the effective use of local technology and transfer of foreign knowledge through the marketing channel (Pietrobelli and Rabellotti 2009, 2011) which they call upgrading instead of innovation (Humphrey and Schmitz 2000, 2002; Giuliani et al. 2005). Consequently, value chain approach is the solution to build the technological base and the market incentives needed for upgrading. While knowledge can be transferred through these channels in relatively strong supplier firms of developing countries (E.g. Ivarsson and Alvstam 2010; Farole and Winkler 2014a), there is no strong evidence where multinationals help African firms to build their local innovative capacity. This could be partly due to the fact that transfer of technology itself, among other things, is highly dependent on the absorptive capacity of firms in the recipient countries (Wamae 2013) and may also attribute to the willingness of multinationals to transfer their knowledge and technology. Thus, there is a need for building endogenous system of innovation locally to operate in and benefit from the global system (Kuhlmann and Ordóñez, 2015).

However, these theoretical concepts are developed almost in parallel and are often interrelated. For instance, the development of a global value chain is facilitated by clustering of supplier firms or producers of raw materials. Moreover, clustering is an effective tool to organize innovation at local and micro-level (Diyamett 2012). Thus, it is an important media for the closer interaction and increased knowledge flow among the members (Diyamett 2012). Clusters are found convenient for analyzing the mode of interaction of bamboo craft enterprises, which is in agreement with Diyamett (2012). However, these scales are not outside of the influence of institutions and, hence, systems of innovations are still preferred. Similarly, global value chains can contribute in analyzing user-producer interaction in an innovation system through its role as a push (knowledge acquisition) and pull (demand) factor. It is particularly important in sectoral innovations (Malerba and Mani 2009; Weiss et al. 2011).

However, in the case of bamboo in Ethiopia, the fact that there is no well-developed local value chain which facilitates knowledge and information flows and Ethiopian bamboo is not yet entered in the global bamboo value chain, the relevance of the value chain approach as a primary analytical tool for the analysis

of innovation based commercialization is found inadequate. On the other hand, system of innovation encompasses both technology and market, and although its emphasis on market is weak, it is still found to be the preferred analytical tool for this study.

Likewise, the SI does not adequately theoriticize the impact of indigenous knowledge and technology and the impact of external knowledge for micro-business innovation. In order to fill this gap this study extended the boundary to include the concepts of technology transfer, clustering and indigenous technology so as to improve its analytical rigor for innovation in developing country and under-commercialized sectoral products. Thus, although the study builds mainly on the innovation system approach, aspects of the concepts of clustering, technology transfer and value chains are applied as an analytical guideline for analyzing innovative commercialization of bamboo in Ethiopia. Moreover, it was not found difficult to integrate these concepts under the rubric of system of innovation. However, a comprehensive theory that helps to study innovations in a sector with a limited technological base and low level of commercialization is still needed. The new theory may be elaborated based on theories of technology transfer including global value chains, endogenous capacity development and the role of intermediaries (particularly government and NGOs). Moreover, firms in developing countries are working in an environment with a long list of obstacles in addition to conventional business challenges. Therefore, theoretical analysis of these environments is equally essential and the new theory may encompass aspects of SWOT analysis.

The study was designed to analyze innovation based commercialization of bamboo in Ethiopia. The national policy and institutional context and direction of change in relation to bamboo sector are similar for most administrative regions. The sample districts and urban centers selected are representative of the other regions with bamboo resources and craft enterprises. Therefore, the model developed can be valid to apply to study bamboo to other districts of Ethiopia. Its applicability beyond Ethiopia and other sectors should be taken with caution. This is because national systems and sectors may have peculiar features which are not tackled by this study. Further case studies may be needed to capture micro-differences among nations and sectors.

Although the study covers the commercialization process from production to consumption, it did not capture the consumers' perspective with reliable sample size. As a result it was not able to provide a fairly detailed and accurate assessment of consumer demand, perceptions and perspectives. A study, possibly a national survey of bamboo consumer survey would provide a pertinent knowledge base and compliment for this study to provide a complete understanding of the commercialization process and its determinants.

Moreover, the case studies conducted are not adequate to capture the depth and breadth of problems and potential of enterprises in commercializing the sector. This was because adequate time was not allocated to assess the daily routines and production processes of craft enterprises. It would be more informative than it appears now if data were collected in this manner, particularly to understand the range of interests of buyers, interaction behavior and transaction outcomes through observation rather than through interviewing of the buyers and sellers. Although the sample size of craft enterprises (32) is large relative to the total enterprises which are estimated less than 100 in the three cities; it is not adequate to produce a rigorous comparative regression model for different types of enterprises disaggregated by size and location. The limitation is minimized by the application of multiple sources of data from group discussion, case studies, expert interviews and document analysis. On the other hand a sample of 133 at the producer level are large enough to provide valid inferences The use of group discussion and baseline surveys further strengthened the validity of the results.

8.8 Conclusion

The systemic innovation approach is found to be an appropriate analytical framework for this research since it is inclusive and adaptable to the enhancement of innovation performance in the bamboo sector. Moreover, since it is evolved from evolutionary technology development and is related to business clusters, it was not found difficult to incorporate aspects of the latter concept in the analysis. In order to accommodate sector and country specific circumstances of bamboo in Ethiopia, the concept of technology transfer and indigenous knowledge has been included in the framework. The limitation of SI in analyzing aspects of market based interactions is complemented by the use of the value chain approach. Therefore, applying the system of innovation as a main analytical tool together with the value chain approach, the thesis has investigated four key issues affecting bamboo innovation and commercialization in Ethiopia.

The first issue is the source of knowledge and technology for innovation and determinants of knowledgeability. The study revealed traditional technologies possessed by local people and embedded in products such as bamboo houses, craft products as well as related traditional sectors are found to be readily available and applicable technological base for innovation by semi-modern craft enterprises. It is found that more than 20 different types of bamboo products are produced by local people. Though the technical skill is not distributed among households and regions uniformly, due to differences in knowledge of use, access to market and bamboo income among community members; it can still be adequate for further upgrading and up-scaling.

These bamboo technologies are however fallen short of creating an industry competitive in global value chain which is dominantly controlled by China and other Asian countries which have comparatively advanced technology and firm organization. As such, there is a need for external technology. However, studies reveal that success in technology transfer is determined by a number of factors with indigenous capability being one of them. Similarly, technology development is path dependent and facilitated by the presence of base technology. Thus, indigenous technologies increase the absorptive capacity and accelerate endogenous technological innovation. This is depicted in the relatively improved technologies of the semi-modern craft enterprises and recreational houses both of which depend on blending of traditional and introduced technologies.

The second issue is the characteristics and performance of entrepreneurial actors. It is found that a range of bamboo processors (enterprises/craftsmen) have been involved in bamboo furniture, craft production, decoration and recreational house construction. The traditional craft producers are generally survival enterprises who produce low quality products with hand tools and mainly trade with poor customers who cannot afford relatively higher quality bamboo and wood products. The semi-modern and medium enterprises have all types of customers and use relatively better technology than the traditional craft enterprises. However, it is found that even these latter groups have only limited export markets for processed products, despite their relatively better access to technology and information. Most of the enterprises are governed by price based competition more than on a quality basis, a condition which limits innovativeness and product development. This remains the case despite the fact that institutional actors, particularly NGOs, have been involved in developing the sector. However, their role is limited to capacity development to craft production and they are hardly involved in market development. Moreover, their activities are project based and lack continuity. As a result, most of the capacity trainings did not lead to new startup businesses. Therefore, the sectoral activities are not organized in systematic approach to lead to transformation of the sector.

In addition to analyzing existing technology and knowledge systems at the various stages of the value chain, the performance and propensity for innovation is also investigated mainly at the processing stage. Thus, the third key issue investigated is the typologies and determinants of innovation in a sector operating with a weak technological level and a small and ephemeral market. In principle, innovation can occur throughout the value chain. However, probably due to the fact that the existing value chain is found short, few actors are involved and interactions are limited and only a few innovations are registered at the processing stage. Moreover, produced innovations are incremental rather than radical. It is found that

innovativeness is constrained by internal and external factors. The major internal factors are technology, capability and finance. The major external factors reported are working space, training support and an enabling policy environment. Although external actors (innovation intermediaries) mainly NGOs and governments have conducted capacity building trainings, their impact is constrained by improper selection of trainees and intervention areas. Moreover, although there are a number of organizational innovation relevant for bamboo commercialization in government institutions, little improvement registered in the organization of enterprises. Moreover, intermediaries such as transporters, brokers and traders are almost absent in the bamboo value chain and their contribution in marketing and organizational innovation is virtually absent. Thus, due to system wide problems adversely affecting innovation propensity, the low number of major innovations registered and a cycle of low quality production and subsequently low demand for bamboo products is still sustained. Thus, the study found that establishment of functioning systems of innovation is essential for broadening the market niche and to enhance the capability of actors to enter in the competitive global bamboo value chain.

Finally, although the study has given greater emphasis to technology and innovation for reasons already described, the overarching purpose of the study is to investigate the options for bamboo commercialization. To this end, other factors affecting commercialization and the rate of commercialization were investigated under existing production systems. The result reveals that distance to market, management investment, infrastructural condition and technologies are identified as the major determinants for differential commercialization. In Sheka regions, education and family size are found to enhance propensity of a family to engage in commercial production of bamboo. The result further reveals that commercialization of bamboo in Ethiopia is low where two-third of the annual bamboo produced are used for household subsistence in the production areas. Moreover, the majority of production, be it subsistence or commercial, is consumed without value addition. Trades are mainly national with very small export markets. It is reported that unprocessed bamboo is being exported legally to Egypt and smuggled via borders to Sudan. Though access to market, management investment and infrastructure are found essential in determining commercial sales, processing technology and weak innovation capability are reported as primary deterrents to innovative commercialization to attract a broader range of consumers. Hence, support schemes for bamboo sector transformation should mainly focus on improving the technological capabilities of bamboo product processors and their competitiveness to enter to the global value chain.

The thesis however does not sufficiently investigated horizontal networks and cooperatives in relation to innovation and value chain development. This gap, particularly the intensity and the quality of networks, the extent of knowledge flowing within the networks and related indicators of social capital which together influence the impact of network on innovation and commercialization needs to be further investigated. Moreover, the impact of negative experience of cooperatives during the socialist era may have an impact in interest for group work arrangements and cluster development, and hence historic analysis of social organizations and cooperative engagements in Ethiopia needs further investigation. Similarly, the study would benefit if it were designed in comparison with other craft sectors and wood-based industries. Therefore, an in-depth analysis of the determinants of innovation in relation to other sectors and with a larger sample size provides an even better lesson for decision makers to choose options and priorities for organizational innovation and strengthen supporting institutions.

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10 Appendices

10.1 Annex I: Questionnaire for Bamboo Producer Households

i. Socio-demographic characterstics

Survey Area: Woreda _____ PA _____ Village _____
Date of interview: _____ Name of interviewer _____ Gender_____
No. of family _____ Marital Status_____ Age _____
Level of Education:_____ Religion_____ Ethnicity_____

ii. Bamboo Production, local knowledge and uses

1. From where you harvest bamboo (natural forest, own woodlot, other persons private holding,

market, other)

2. How much is your own holding in hectar?

3. Do you obtain from other farmer? a) Yes……. b) No…… c) how much culm

4. Do you manage bamboo stand? a) Yes……. b) No……

5) If yes,

c) What type?

d) How much time you spent?

6. If no, why?

7. Do you treat bamboo before use? a) Yes……. b) No……

8. What type of treatment?

9. Do bamboos are the same type? a)Yes….. b) No…..

10. If yes, what are the types?

11. What is their difference?

12. Which criteria you use to determine the utility of bamboo for a certain product?

	Required criteria				
Product type	yield	Maturity(strength)	aesthetics	workability	other

13. For what purpose one can use bamboo?

14. Do you use bamboo or its products? a) Yes……. b) No……

15. If yes, for what purpose?

a. Fencing	**b.** Food
c. House construction(for which part of the house)	**d.** Cooking food
e. Furniture(list specific uses)	**f.** Feed
g. Household Utensils (mention type)	**h.** Medicine
i. umbrella	**j.** Ornamental
k. Agricultural tools	**l.** Spiritual(mention specific use)
m. Walking Sticks	**n.** Other uses(mention)

16. If you are asked to choose between wood and bamboo product, in which situation bamboo preferred and the reverse?

iii. Bamboo Technology and Processing

1. In what form (raw, processed, both) you use bamboo?

2. If processed, list the steps to reach the required level?

3. Do you do the processing? a) Yes…….. b) No……..

c) If yes, from whom you learn the kill?

d) If no, who else make products for you and which product?

4. What types of tools and equipment used for processing? Please list with their respective uses

5. Do you produce the tools and equipment yourself? a) Yes…. b) No…..

c) If yes, which types?

d) If not, where you get them?

iv. Institutional support for technology transfer (development)

1. Do you or other family member get bamboo education/training? a) Yes…. b) No…..

c) If so, how many times?

d) What type of training?

2. Who (government, trader, NGOs, R&D institutes, family member, other)?

3. If trained, what benefits you get from skill trainings? a) Yes…. b) No…..

c) Have you applied it?

d) If no, why not?

v. Income from bamboo and market pattern

1. Do you or your family member get income from bamboo?

a) Yes, amount in no. of culm and value (birr)------own consumption …….. Bartering……..

b) How much is the culm price?

b) If for consumption, what type of bamboo/ products you use this year?

No.	**Product**	**raw or processed**	**If processed, who do the processing**	**Amount of culms used**

4. If you sell bamboo culm,

a) Who are your buyers?

b) How is price fixed?

c) Where you sale?

6. Is there a change in the price of bamboo culm? Yes……. No……

7. Why do you think the reasons for the change?

8. Is there any quality criteria your buyers demand you to fulfill? Yes……. No……

9. If yes, which product qualities?

Vi. Household income and income source

1. Crop, vegetables and fruit income

Type and quantity	value	Input/cost	Net -value	Own use	Sale

2. Livestock and value added products

Livestock and products used and sold	value	Input/cost	Net value

3. Forest products

Type and quantity	value	Inputs/cost	Net value

4. Non-farm income

Source and quantity	value	Inputs/cost	Net value

10.2 Annex II: Questionaire for Enterprises

1. Basic Entrepreneur information

Name_____ age____ education____ year in the business_____ working city_____

No. of staff: permanent___ temporary ____ No. of family staff_____ Internship ____

Do you work full, par-time, other?_____ workshop/display place: _____

How and why you join the bamboo business?

2. Bamboo Products and technology

1. What type of product you produce?

a) Now :

b) Five years ago:

2. How much of each product you produce per month?

3. Do you specialize in certain products? a) Yes…… b) No…… c) Why?

4. What types of tools and equipment you use for bamboo processing?

Tools/equipment	Who made it	purpose	Preferred substitute

3. Technical training and capacity building

1. How do you learn bamboo processing?

2. Do you get any training/s? a) Yes…… b) No……

c) If yes, What type?

d) Who give you the training?

3. What about your employees?
   a. Trained by you,
   b. trained before employment,
   c. allowed on-job training elsewhere

4. Do you ever face problem of finding training institution when you want to train? a) Yes…… b) No……

4. Network and communication

1. Do you discuss about improving your product quality and diversity with other processor?

a) Yes…… b) No……

c) If yes, with whom?

d) Why or why not?

2. Do you get any specific technical skill or market information as a result of communication?

3. Do you get experience from outside of your village? Where?

4. Do you have exposure to foreign products?
   If so, do you intend to upgrade your production?
   a. to the same level,
   b. to higher standard,
   c. no plan in the near future

5. Do you share your experience? a) Yes…… b) No……

6. If yes, to whom?

7. Do you have contact with research institutions, NGOs, GOs or other for the purpose of your business?

a) Yes…… b) No……

c) If so, what were the areas of collaboration?

8. Are you a member of any business association? a) Yes…… b) No……

c) If yes, what type?

a. Experience sharing
b. Information exchange
c. Sharing and borrowing of tools and equipment
d. Joint buying of inputs and selling of products
e. Sharing work force
f. Group work
g. Other

9. Why intra-business cooperation needed or not needed?

5. State of innovation and innovativeness

1. Have you produced unique products? a) Yes…… b) No……

2. If yes, how many in the last 5 years?

Innovation type	How many(No.)	Nature of change*	Source of innovation**
New products			
Distribution system			
market			
Quality modification			
Organization system			
New machine			

* radical, incremental, small changes
**Who are the sources of innovation? Own idea (trial and error), local competitor, GO/NGO expert advice, from literature/mass media, internet, design handbook, R&D institutes, local knowledge, foreign company etc

3. Are the changes new in the city? Which aspect makes it unique?

4. Why is engagement in innovation necessary?

5. Are you interested to significantly change your working style and mix of products?
a) Yes…… b) No……
c) If yes, will you do it under existing situation? a) Yes…… b) No……

6. Which issues do you think are the most critical factors affecting your innovative production effort?

a. Finance
b. Capacity/skill
c. Market availability
d. Technology
e. Trained staff
f. Other

7. How you rate the following issues in relation to innovation (if you strongly agree give one, if strongly disagree give five and if your view is in between give values within this range)

Issue	1	2	3	4	5
Innovation is my priority					
Business survival not innovation is my priority					
Innovation is part and parcel of the business					
Innovation is essential for business development					
Innovation obtained by chance					
Competition hinder me from innovation					
Access to knowledge is my obstacle					
The working environment is not conducive					
Limited knowledge hinder me from innovation					
Other					

6. Business support institutions

1. Could you list tangible support you get from organizations, if any?

2. Are the service supports you get adequate? a) Yes…… b) No……

3. If no or if more, what services you expect to get from government to develop your business?

a. Micro-finance
b. Production and marketing space
c. Market linkage and promotion
d. Training
e. Financial support
f. Policy support, specify

4. Do institutions affect your innovation effort? a) Yes…… b) No…… c) How?

5. Do you have bamboo work license?

7. Supply chains and business relations

1. Where you buy your culms (place)?

2. Why you prefer this area?

a. Short distance
b. cheap
c. Durable bamboo
d. Big culm size
e. Good aesthetics
f. Just by tradition
g. Other reasons

3. From whom you buy? a) Producer___ b) Trader____ c) Other, specify_____

4. Do you buy from permanent customers? a) Yes…… b) No……

c) If yes, does it have any advantage? d) What?

5. Is there a change in price of culm and processed products? a) Yes…… b) No……

6. How much was it in 2007 and 2012?

	2007	2012	Quality improved?	Remark
Single culm				
With truckload				
Chair Duka Sofa				
Table				

Bed				
shelf				

7. Do you record your monthly cost? How much was it for instance the previous month?

8. What about your monthly revenues?

9. How do you fix price of your products?

10. Who are your major customers?

12. What is your plan in the future?

a. Continue in the same sector
b. Change to other sector
c. Diversify
d. Other

Why?

13. What are the major obstacles in your business?

a. Skill and education
b. Low Workers' motivation and skill
c. Quality of working equipment
d. Decreased availability of raw material
e. Rise in raw material cost
f. Decrease in raw material quality
g. Bureaucracy
h. Corruption
i. Lack of demand for bamboo
j. Transportation
k. Finance
l. Other

14. Your comment on the bamboo sector development

10.3 Annex III: Questionnaire for Survey of Consumer

Basic information on the interviewee

Survey Area:_____ Name:_____ Gender_____

Age _____ Level of Education:_____ Religion_____ Ethnicity_____

Interviewee type: Business/private (underline)

1. Are you familiar with bamboo and bamboo products
   a) Bamboo Yes…….No…….
   b) Bamboo products Yes…….No…….
2. How do you perceive bamboo tree?

3. How do you come to know bamboo products?

4. Have you ever use bamboo products? Yes…….No…….

   if yes,
   a)What type/s of product/s?

   b) How much you bought your recent item?

   c) How frequent you buy bamboo products? sometimes, often, frequently
5. Why you choose to use or not to use bamboo? It is cheap, it is durable, easy to use, aesthetic beauty, abundantly available, other

6. Which qualities of bamboo product your customers like?

7. If you are asked to choose between wood and bamboo product, in which situations, you prefer one over the other?

8. How do you rate bamboo quality, for example, compared to wood?

9. What criteria you would like to be fulfilled for bamboo products to be most preferred product?

10. How do you rate existing bamboo products quality?

11. Based on your assessment, what does a bamboo processor lack?
12. Do you think the processors need support? Yes…….No…….
13. What do you think other agencies can contribute towards improving the quality of bamboo products?

14. Do you have any other comments on market, product development etc? Please explain

10.4 Annex IV: Overview of Bamboo Resource

Bamboo is a fast growing species and high yielding renewable resource (Chaowana 2013). While there is variation within them, most bamboo species mature and reach for utilization faster than other fast growing tree species. Size of bamboos vary from dwarf bamboos which may be as small as a few centimeters to those large bamboos like Dendrocalamus giganteus which reach up to 40 Meters height (FAO 2005). Bamboos attain its maximum height and diameter growth in one growing season (Aminuddinn et al, 1991) (Mengesha 2011) and maintain this size while continuing lignification for the years to come. During this process, the cell wall thickens, the specific gravity increases, moister content decreases and the mechanical and physical properties enhanced (Chaowana 2013). During the growth period, the moisture content can be up to 80% and after about 4 years, it lowers to around 20% (Minke 2012). When lignification completed, usually after six years, the vascular bundles close and dry out then will be ready as a raw material for high quality construction (Minke 2012).

The unique features of the various bamboo species enable it to adapt to different climate and soil conditions, which in turn explain its wide global distribution (FAO 2005). While it thrives in almost all over the world, it is distributed largely in regions with tropical, subtropical and warm temperate climates. Despite its global range, the largest bamboo area coverage and species diversity is found in Asia (see table 10.1). China and India alone possess a third of the global bamboo resource and nearly two-thirds of the world's bamboo species. The least number of bamboo species occurs in Africa, with only 43 species (Embaye and K. 2003; Mengesha 2011).

Bamboo area coverage in hectare and species distribution by region

Region	Area (2010 estimate)	Species
Asia	17,360,000	1012
Oceania	45,000	
South America	10,399,000	515
North and Central America	39,000	
Africa	3,627,000	43
Total	31,470,000	1439*

Adapted from: (FAO 2010; Bystriakova et al. 2003; Embaye and K. 2003)

*Species number does not add up to the total since there is species overlap and figures change continuously as new species described

10.5 Annex V: Transforming Traditional Huts into Modern Tourist Lodge- The Case of Aregash Lodge

Aregash lodge is the first bamboo lodge ever constructed in Ethiopia. It is constructed in 1994. Mr. and Mrs. Missailidis, together with their extended family members developed the business idea to invest in tourism lodge mainly to commemorate their forefathers. Linking the business to their family root in Sidama and the unique Sidama culture was the primary criteria in selecting the business type. Among the lists of options that satisfy this objective, the owners recalls, bamboo recreational lodge was selected as the best with the entire family member.

Ones the business idea approved, Mr. and Mrs. took a long time on how to transform the traditional bamboo huts into a tourist comfort without losing its traditional authenticity while fulfilling tourist satisfaction. Initially strengthening with wood beams, constructing the entire wall with wood, and concrete walls were taken as possible options but were dropped since they do not fulfill the traditional Sidama house architecture. Finally, a compromise of strength and authenticity of the house was made by constructing the house purely by bamboo but supporting with concrete basements and floor. Then decoration of the internal and external parts , introducing traditional Sidama crafts and artworks inside the bungalows, furnishing all the inside with bamboo and other local material, serving with local food, making bamboo one of the ornamental plant inside the lodge together with other indigenous products. Bamboo culms properly dried treated with chemical before and after use in construction and furniture. These lists of activities have been implemented as planned. The process has transformed the traditional house into modern lodge with attractive market and business sustainability. It is reported that the lodge is fully booked throughout the year. Customer rating is excellent. More than ten staffs, most of them from the region, are employed

Furthermore, the success of this enterprise has led to the proliferation of bamboo lodges. Before 1994 there was no bamboo lodge in Ethiopia. Since then over 20 lodges are constructed with bamboo throughout the country and it is still expanding. A number of restaurants and coffee houses, including in the capital, have also used bamboo for construction, decoration and furnishing. The manager reported that several of the lodge and restaurant owners visited and consulted the owners prior to their construction. However, he has reservation on some of the lodges which are construct mimicking Sidama house outside of the region arguing that they are limiting diversity and innovation by failing to use local house designs. He also iterates that this also affect tourist satisfaction and development of the business.

The use of bamboo in lodge construction has significantly contributed for the price improvement of bamboo. It is reported that price for culms increased from about 50 cents in 1994 to around 15 birr per culm in 2014. The price of bamboo leaves (material used for thatching) has skyrocketed from 100 birr per track load to about 2000 birr. It is reported that it is not even possible to find enough bamboo leaves since demand is much higher than the supply. Thus, bamboo producers have benefited from the commercialization aroused from traditional house transformation to recreational/tourist lodges.

It is however reported that during the childhood of the owner, much of the surround areas to the lodge had extensive bamboo coverage and bamboo houses. Nowadays, there is no bamboo stands and bamboo houses in this area.

10.6 Annex 6: Bamboo Trainees Disaggregated by Sponsoring Organization in Different Regions of the Country

No. of Trainee	Sponsors	Trainees' Region
43	World Vison	Benishangul Gumuz, Oromia, SNNRS
26	Beneshangul Gumuz SMEs promotion Bureau	Benishangul Gumuz
30	Beneshangul agri Bureau	
25	Assosa Trade and Transport Bureau	
30	C.I.S.P	
79	Amhara SMEs promotion office	Amhara
14	Awi zone trade and industry office	
20	Menschen fuer Menschen	Oromia
30	World wildlife fund	
42	Farm Africa	
39	Oromia SMEs promotion bureau	
15	Ethiopian self-governance	SNNRS
40	Irish AID	
34	Miserach edetibeb	Addis Ababa
32	Genet Church	
3	Abebech Gobena	
19	hulegeb community organization	
2	Dombosko	
4	Mekaneyesus	
11	Private	
6	CCF(Chirstian children fund)	
4	Immigrants and Returnees association	
1	Opride Ethiopia	
1	Tehadiso	
1	Ziway Prison	
3	Handcape National	
2	Redbarna	
1	Rasgez Setoch/selfhelp Women associ.	
1	Muluwengel	
1	Gebae Egiziabher	
94	Sponsor is not recoded	

Source: FeMSEDA

10.7 Annex VI: Summary of Institutional Changes Relevant for Bamboo Innovation

Agencies	Relevant changes	Limitations and challenges
Ministry of agriculture	The forestry component of the ministry separated and upgraded to form ministry of forest and environment Forestry policy promulgated Policy shows the changes from protection/conservation to more responsible utilization and management Bamboo management and utilization framework developed A separate unit overseeing bamboo sector established Enterprise based management started in forestry sector Locals have access right to non-destructive harvest even from government owned forests	Policy implementation guide to be developed As a new structure, more staff to be employed for full functioning Still limited private sector involvement Bamboo production and trade was not yet adequately promoted Curbing illegal international bamboo trade is needed
Science and technology commission	upgraded to ministerial level structure Deals with science, technology and innovation development Policy document prepared Focus on Technology transfer and adoption Facilitate R&D and industry linkages Promote & support applied research undertakings, especially adaptation research & TT	Too much focus on technology transfer, less staff to monitor technology transfer Focus on only high value industrial products Inadequate trained staff, high attrition rate
Ministry of industry	Divided into two and the ministry of industry will focus on development of large scale company development Industry policy developed Promote investment on high potential Ethiopian national resources Industry development	Does not oversee SMEs. Young institute, poorly staffed
SMEs Agency	The SMEs become more autonomous under ministry of urban development and construction. strengthens TVET for producing next generation crafters Parallel bureau are established in regional states	Emphasis is on urban SMEs Bamboo subsector experience severe staff attrition as the mandate changed from processor and trainer to a trainer of trainers. The former staffs were reported as less trained for the new role and few places allotted.

10.8 Annex VII: Cost estimate and benefit distribution from a bamboo sofa set production

Levels	Cost Drivers	Estimated Cost	Sale Price	Profit Margin (%)
Processing	Bamboo raw material(25 culms)	450		
	Cloth(sofa cover)	250		
	Comfort sponge	300		
	Labour	310		
	Varnishes, glue, gasoline	80		
	Nails	50		
	Glass	150		
	Plywood/lumber	100		
	Electric and house rent	50		
	Depreciation cost of tools and equipments	50		
	Administrative cost	160		
	Annual tax	25		
	Total	1975	3000	**34.17%**
Trader	Transportation	1.50 birr/culm		
	Loading and unloading	50 cents/culm		
	Taxes and other costs during transportation	30 cents/culm		
	Yard rent and administration cost	20 birr		
	Total cost for 25 culms	302.5 birr	450	**32.78%**
Producer	Management (22 cents)	5.5		
	Selection and harvesting (40 cents)	10		
	Land price (lease/tax for use)(20cents)	5		
	Total cost	20.50	225	**90.89%**

Notes:

1. Data source: case study 2012
2. A sofa set requires 25 culms with about 60% usage rate (40% wastage) of total culm volume.
3. Percent profit margin = (revenue –cost/revenue)*100
4. The price of bamboo and the value added products varies due to a number of factors. For instance, the price of bamboo varies based on stem size, the stem quality, the transportation cost/distance. Similarly benefit distribution varies by number of actors in the chain, the processing city, the level of value addition practices before consumption. Despite these differences, the two enterprise studied in-depth is used as a reliable source of data, as most of the intermediate inputs thoroughly observed and costs documented.

5. Official land lease price is terribly low. However, farmer to farmer land transaction in terms of lease gives a better estimate of actual land price. The average land lease price for bamboo growing (a land with low fertility level) is estimated 500birr per year/hectare. It is estimated that 1000 culms can be harvested annually. Therefore, the price of land for one culm will be 20 cents.
6. The labour price for bamboo management is also very small. The survey shows that the average man-day a farmer invests in bamboo management is about 2mandays/year (chapter 7.2.1). Average bamboo land holding is around 0.1 hectare. If one manday is 20 birr, the total cost will be 400birr per hectare. Thus, management and harvesting cost will be 22 cents per culm. All the labour force is obtained from their own family.
7. Despite trades enjoy higher proportion of profit margin than processors, trading is not considered as attractive business since there is no adequate demand. Craft enterprises often bypass traders buy themselves from the production areas. When the traders avoided, the benefit of the processing enterprises will increase by same proportion. In this situation profit margin for craft enterprises may reach to 39.92%.

11 Declaration on the Opening of the Doctorate Procedures

1. I hereby assure that I have produced the present work without inadmissible help from third parties and without aids other than those stated; ideas taken directly or indirectly from external sources are identified as such.

2. When selecting and evaluating the materials and also when producing the manuscript, I have received support from the following persons: Prof. Dr. Jürgen Pretzsch, Prof. Dr. Ralph Mitlöhner and Dr. Tefera Mengistu Wolde.

3. No further persons were involved in the intellectual production of the present work. In particular, I have not received help from a commercial doctoral adviser. No third parties have received monetary benefits from me, either directly or indirectly, for work relating to the content of the presented dissertation.

4. The work has not previously been presented in the same or a similar format to another examination body in Germany or abroad, nor has it - unless it is a cumulative dissertation - been published.

5. If this concerns a cumulative dissertation in accordance with Section 10 Para. 2, I assure compliance with the conditions laid down therein.

6. I confirm that I acknowledge the doctoral regulations of the Faculty of Environmental Sciences of the Technische Universität Dresden.

Tharandt, 1 June 2015

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Tefera Belay Endalamaw