

Internal Paper 82



កិច្ចសហប្រតិបត្តិការ
អាណ្លើម៉ង់
DEUTSCHE ZUSAMMENARBEIT

Bamboo Sticks Prospectus,

October 2013

Regional Economic Development Program (RED) Green Belt Siem Reap



giz

Regional Economic Development Program (RED)
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Investment Opportunity

Bamboo Sticks Prospectus



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1 Introduction

The bamboo industry is recognised globally for its potential to simultaneously tackle poverty and climate change while offering an excellent business opportunity to investors. The Cambodian-German Technical Cooperation Program "Regional Economic Development (RED) – Green Belt" has been working with businesses, administrative units and communities to build long term economic opportunities that reduces poverty in promoting bamboo business and forest management. The program is aiming at a growing turnover of regional products, the development of new business opportunities, and increased employment.

This work is a part of GIZ's RED Program mission, GIZ team in Siem Reap has worked with international consultants and bamboo experts to present an investment opportunity in bamboo industry, which represents a viable high-return opportunity with a significant positive impact on poverty-reduction.

The present report introduces Bamboo Sticks Investment Opportunity in the context of investment in Varin district, Siem Reap province, Cambodia. The report also provides indicative figure of an investment project in bamboo sticks in general.

The purpose of this paper is to provide investors, entrepreneurs and businesses with tailored information on bamboo sticks as an investment prospect in Varin district, Siem Reap province, Cambodia. This report describes the bamboo sticks market, product diversification, manufacturing process and financial analysis including expected returns from a bamboo sticks investment project.

The GIZ-RED Program is collaborating with international bamboo experts to set up a package of services to support bamboo sticks investors including business model, technology solutions and sustainable bamboo supply management.

2 Industry Analysis and Market Outlook

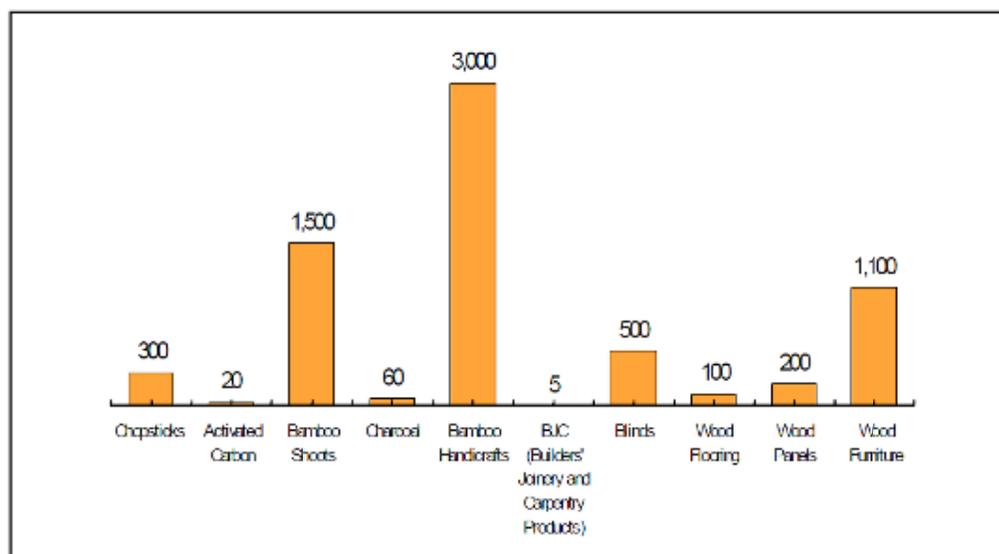
2.1. Market for bamboo stick products

The bamboo stick products market divides into several segments, of which two major segments are chopsticks and toothpicks. The other segments including barbecue sticks, incense stick and mat sticks, are small but are recently fast growing.

2.1.1. World market for bamboo chopsticks

Figure 1 below shows size of selected bamboo products markets, where the world market for bamboo chopsticks is estimated at US\$ 300 million in 2006¹. While the world market for chopsticks is estimated at US\$400 million, the balance is accounted for by chopsticks made of other materials like wood, plastic and steel).

Figure 1 - Size of selected 'Bamboo Markets' (US\$ m)



2.1.2. World major producers and consumers of bamboo chopsticks

Official data on bamboo chopsticks production is not available, but some reports show that chopsticks making in the Far East is a fragmented industry, working with old technology and suffering from a lack of natural resources. In Asia, chopsticks are produced in very small quantities, often by family organizations. Even the largest of the 450 chopstick factories in Japan turns out only 5 million chopsticks a month. This compares to an overall market size of 130 million pairs of disposable chopsticks a day.

¹ Oxfam Hong Kong and IFC, 2006.

China is the biggest chopsticks producer and China is also the biggest consumer of chopsticks in the world. According to Chinese statistics in 2011², the country's manufacturers produce 60 to 80 billion sets of chopsticks each year. Forty percent of production is used for domestic market and 60% are exported. According to 2008 Comtrade statistics, China's export of bamboo chopsticks and sticks reached US\$105 million in 2008 (US\$75.5 million for chopsticks and US\$29.5 millions for other kinds of stick). The major importers of Chinese chopsticks are Japan and South Korea.

Japan stands in the second place in consuming chopsticks. Each year, the Japanese use 23 to 25 billion pairs of disposable chopsticks equating to approximately 200 pairs for each person. The usage is so high that the Japanese government recently imposed a chopsticks tax for environmental reasons. To remain attractive to increasingly environmentally conscious consumers, chopstick importers in Japan have started buying bamboo chopsticks, as bamboo is a more sustainable material.

Other significant producers and consumers of chopsticks in the world are Korea, Taiwan, Vietnam, Cambodia, and Laos PDR.

2.1.3. Bamboo chopsticks price

According to the Chinese statistics³, the export unit price in 2008 was US\$1,248.45/m³ which rose by 11.16% compared with US\$1,120.11/m³ in the previous year. In China, recently value and unit price of the import and export of the Chinese bamboo chopsticks have comprehensively increased. This is because the resources situation and the policies in China. In recent years, China has carried out a series of macro-control policies and measures to restrict the wooden products which consume higher levels of resources and has encouraged the production and export of products made from bamboo. Faced with shortages of supply and price increases, China's import of chopsticks has been increased too.

By observation by the authors in the Vietnam bamboo chopsticks market in 2012, the ex-works or wholesale price of disposal bamboo chopsticks ranged from US\$900 to US\$1,100 per ton.

2.1.4. Other sticks - consumers and price

As mentioned above, the other segments including barbecue sticks, incense stick and mat sticks, are small but are recently fast growing. Lack of data on trade of bamboo barbecue sticks, incense stick and mat sticks, however following our survey with producers of these bamboo sticks in Ha Tay province, Vietnam, and traders in Siem Reap, Cambodia, the below information is useful for new investors in the context of Cambodia business.

Bamboo barbecue sticks are considered as a sub sector of bamboo chopsticks, because it's derived from chopsticks production. Bamboo barbecue sticks are manufactured under chopsticks' production process and machinery system. In Vietnam, almost investors set up a production line to produce mix of chopsticks and barbecue sticks. Per GIZ-RED Team's survey in Siem Reap market, the landed cost of barbecue sticks imported from Vietnam range from US\$1.5 to US\$1.67 per kg.

² Report on Chinese Bamboo Chopsticks Industry from 2009 to 2012.

³ Report on Chinese Bamboo Chopsticks Industry from 2009 to 2012.

The mat stick and incense sticks have long history of trade, but not all countries having bamboo can produce these sticks at the same quality level and efficiency. Example, India has largest bamboo areas in the world, but India is a big importer of bamboo incense sticks. Following the interview with major producers of bamboo incense sticks in Vietnam, 40% of their bamboo incense sticks are exported and almost products are exported to India. The challenges in producing bamboo mat sticks and incense sticks are technology issue and suitability of bamboo species.

As many other countries, bamboo mat and incense are the common products in Cambodia. Lack of information on bamboo incense sticks, but we found bamboo table mat are present at many souvenir shops in Siem Reap and all these products are imported from Vietnam. Data on price of bamboo mat is not available but we estimate that bamboo mat sticks are valuable at around US\$900 - US\$1,000 per ton. While Vietnam's FOB export prices of round incense sticks are reported as below:

Vietnam's FOB export prices of bamboo incense sticks⁴:

1. Length 20.5 cm, counting 2800- 2900 sticks/kg: US\$770-US\$800/ton.
2. Length 23.0 cm, counting 2500-2600 sticks/kg : US\$750-US\$770/ton.

2.1.5. Cambodian demand for bamboo sticks

Cambodians commonly use chopsticks and other kinds of sticks. Disposable chopsticks and skewers are used in restaurants, roadside food sellers in most locations in the country. Local market places sell these products sourced from Vietnam and china. Incense sticks are also commonplace in households in Cambodia. An upcoming study by GIZ will better detail the domestic demand scenario for bamboo sticks in Cambodia. As a sample, preliminary estimates for Siem Reap range from 150 to 180 tons of bamboo chopsticks and skewers per year, with most supply coming from Vietnam and a smaller portion coming from China.

2.1.6. Market potential for bamboo chopsticks / sticks

The world market for chopsticks and sticks is predicted to grow as many people are learning to use chopsticks and other kinds of sticks. The world's largest consumer has also imposed restrictions to increase bamboo stick demand including a 5% tax on disposable wooden chopsticks, and in 2007, a new management standard requirement for catering enterprises to reduce domestic usage of wooden chopsticks. High demand of China's domestic market for bamboo chopsticks will have considerable impacts on the international market. It this creates an opportunity for the rest of the world to produce and compete imported Chinese bamboo chopsticks and sticks in their own markets. It also creates the export opportunity to compete with Chinese exports in other locations. In Cambodia, with specific advantage of low price of bamboo material, Cambodia's bamboo sticks are potentially competitive with imports.

⁴ Survey with major bamboo incense sticks producers in Vietnam, 2012.

2.2. Investment opportunities for bamboo sticks

The following SWOT analysis summarizes the strengths, weaknesses, opportunities and threats of an investment in bamboo sticks in Siem Reap Province (including various forms of sticks like chopsticks, skewers, toothpicks, incense sticks, mat sticks).

<p><u>Strengths</u></p> <ul style="list-style-type: none"> • Sufficient bamboo resources are available for commercial exploitation against pressure on wood demand and price. Bamboo is fast growing with a short cultivation cycle, and new plantation can be readily established to secure future supply. • Very strong support from Varin district authorities and its partner GIZ for new investors in bamboo processing • Positive investment promotion policies: land lease, tax exemption, bamboo plantation. • Low labor cost and low cost of bamboo raw materials. • Local first mover competitive advantages. 	<p><u>Opportunities</u></p> <ul style="list-style-type: none"> • Large, growing domestic and global market. • Technological processing is simple for entry to industrial level. • Business model requires limited capital, expertise, scales of operation, level of management. • Business model, technical advice and other support provided by GIZ. • Potential high return on investment.
<p><u>Weaknesses</u></p> <ul style="list-style-type: none"> • Limited local skills in the sector. Lack of local expertise on bamboo and processing technology. • Lack of international market development capacity. • Existing bamboo forest stands under-manage status. Plantations to be developed to secure future supply. • Production must secure energy source/electricity supply as there is a very limited electrical grid. This should be done i) in consultation with local authorities supporting new power plants and distribution, ii) through joint venture options with power plant or iii) self production. 	<p><u>Threats</u></p> <ul style="list-style-type: none"> • Existing resource base is in poor condition, remote, limited varieties. • Limited business services in the production location.

Conditions for a successful bamboo sticks investment will vary between specific projects however opportunities look promising for businesses in Cambodia where bamboo resources are readily

available. Support from Local Government, GIZ, and other partners will be available target the known challenges, to maximize the opportunity for success.

3 Product and Technology

3.1. Sticks product definition

Sticks products in this prospectus are defined as different kinds of stick made of bamboo materials, including:

- fine / disposable chopsticks,
- barbecue sticks / skewers used in barbecue,
- sharp / VIP toothpicks,
- incense sticks used in incense products and
- mat sticks for making table mats, decoration mats, floor mats or blinds.

General specifications are described in Table 2. A specific specification can be achieved by adjusting and re-arranging production line.

Table 1 - Sticks products specification

Products	Length (mm)	Diameter (mm)	Quality requirement
Fine Chopsticks / Disposal Chopsticks	180 to 240	4.0 to 6.0	Food Safe
Skewers / Sticks	150 to 300	2.5 to 4.0	Food Safe
Sharp Toothpicks	65	1.5 to 2.0	Health Safe
VIP Toothpicks	65	1.0	Health Safe
Incense Sticks	200 to 230	1.0	Environment Safe
Mat Sticks	200 to 400	2.0 to 2.5	Contact Safe

3.2. Technology and manufacturing process

The production process and associated equipment has matured over more than 3 decades. There are various suppliers and variations on production techniques and in general, the bamboo sticks manufacturing process is complicated relatively straight forward processing operation. However the bamboo sticks quality levels and types of sticks require different operation scales and production line designs, each varying in the sophistication and scale of machine and equipment systems.

Fundamentally, bamboo sticks technologies are divided into two levels:

1. **Low processing technology** is very simple way of making bamboo sticks with limited machine and equipment requirement. However, the rate of utilization of raw bamboo materials is lowest (around 10%), which results in high volume of waste and residue, and lower commercial value of finished products due to the imperfect shape and rougher surface finish resulting from the machine process and;
2. **High processing technology** maximizes utilization of bamboo materials (to 25%) and produce quality product output. The disadvantage of such technology is high level of investment in machinery and equipment.

Simply, these two technologies are described in below pictures:

a) **Low processing technology**

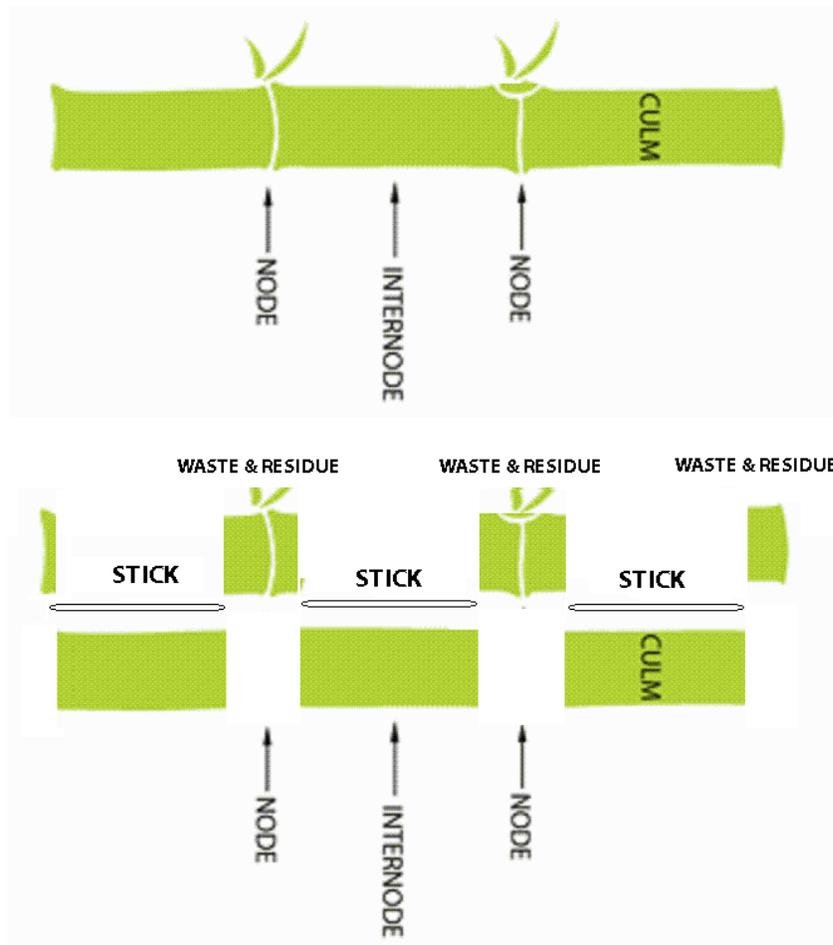


Table 2 – Output for configuration model of low processing technology

Items	Rate (output/input per unit fresh bamboo culms)
Raw wet chopsticks	18.8%
By-products and consumption	82.2%
- Node dust	28.4%
- Chopsticks dust	23.8%
- Consumption (steam, sawdust)	30.0%
Utilization rate: Dried Finished Product	10.4%

Data from bamboo chopstick production in Thanh Hoa province, Vietnam

b) High processing technology

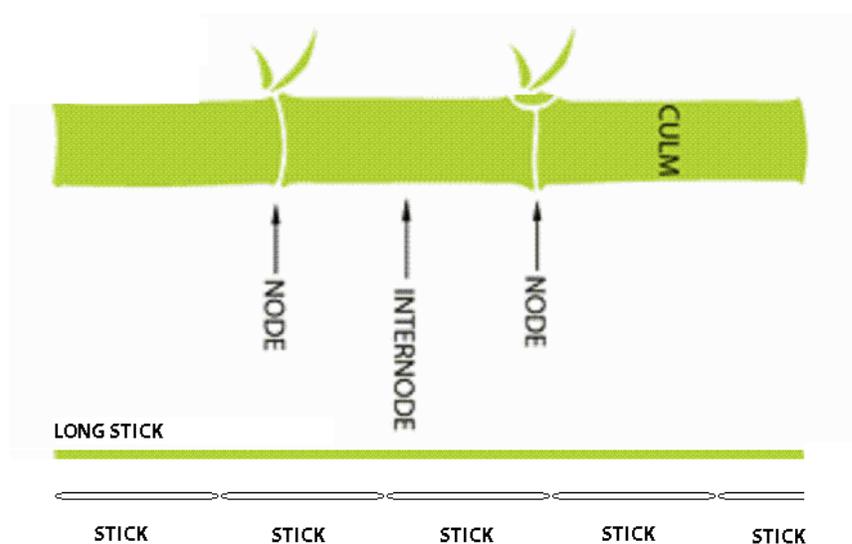


Table 3 – Output for configuration model of high processing technology

Items	Rate (output/input per unit fresh bamboo culms)
Raw wet sticks	50%
Wet Dust Output	15%
Wet Chopping Output	30%
Wet Non-Recoverable Waste	5%
Utilization rate: Dried Finished Product	28%

This prospectus focuses on the recommended model for higher processing technology application due to greater market versatility of the product. The following part of this section will describe manufacturing process for high technology production model. A simple manufacturing process of low technology production model will be seen in detailed in Annex 2.

Given the high energy prices and therefore value of biomass as feedstock to energy generation in Cambodia, a business model for bamboo residues will be also outlined in Annex 3. Bamboo residue

can also be ground into powder used as an industrial additive and for use in incense sticks. As a rule of thumb, finished bamboo stick products will be valued upwards of \$1000/t while the value of dried biomass residues for energy production are \$10/t in Siem Reap (\$40/t in Phnom Penh)⁵. Ground bamboo powder made from grounding up bamboo wastes is used in various industrial applications and is valued at \$100/t in Cambodia. Each product will have specific market opportunities. Regardless, it makes sense to maximize the output of bamboo stick products and avoid waste.

The main stages in typical production process of bamboo sticks are as follows:

1. Bamboo Sawing	
2. Bamboo Splitting	
3. Slats Planning (2 to 5 slats)	
4. Round Stick Filament Size Setting (All kinds of sticks)	
5. Polishing	
6. Length Size Cutting	
7. Round Chopstick / Stick Head Sharpening	8. Stick Length Cut Multi-Knives Machine (6.5 cm)
	9. Round Stick Polishing
	10. One/Two Head Stick Sharpener
	11. One/Two Head Stick Polishing
12. Toothpick/Stick Classification and Arrangement	
13. Packing	
Output: <i>Chopsticks / Skewers / Incense Sticks / Mat Sticks</i>	Output: <i>Sharp Toothpick / Thin Sticks / Toothpick VIP</i>

For further information about the major activities, machines and basic manufacturing process requirements refer to Annex 1.

3.3. Equipment and technology transfer

Bamboo sticks processing is highly developed in China and other Asian countries like Vietnam, Indonesia and Thailand. In these countries, equipment and technology are proven and mature.

In countries with a developed bamboo industry, the machinery and equipment manufacturers' own technology and expertise capabilities allow an end to end service of technology transfer integrated with machinery supply. As with many other industries, technology is considered as one of the key success factors. Furthermore, the cost of technology transfer for bamboo sticks manufacturing is relatively inexpensive compared to the scale of investment.

The authors have a range of connections and partnerships with trusted machinery and equipment suppliers and experts from China and Vietnam. The GIZ project can therefore link new investors to equipment and technology suppliers and coordinate the suppliers and investors' relationship and contracting activities.

An outline of machinery and equipment is attached in Annex 1 for reference.

⁵ Field data, Siem Reap November 2012.

3.4. Raw bamboo material and supply

3.4.1. Bamboo species suitability

One of the key advantages of the present bamboo sticks business model is that the production line is designed for flexible production of various types of sticks (chopstick, skewers, toothpicks, incense sticks and mat sticks). Thus, it can be made from a range of bamboo species of varying sizes and thicknesses. Hardness, particularly node strength may be a limitation to various production processes and equipment which split culms over the multiple nodes. With hard bamboo, there will be the risk of splitting at the node, and the hardness of the material may also limit the splitting capacity of machinery.

The preliminary findings⁶ for bamboo resources available as input material for commercial stick production demonstrates only one species, locally known as Russei Prey as available now for stick processing. Other bamboo species are locally grown at the household level (Russei Srok, Russei Ping Pong) are in too small volumes for commercial exploitation, or are unsuitable for stick production (Russei Khlei and Russei Priek). Other species may be developed in the future and more information on plans for new plantations can be obtained from GIZ.

Bamboo stick production requires uniformly aged and sized bamboo culms so that the production line settings can be maintained. The existing standing supply of Russei Prey is aged and will provide suitable uniformity. Stick production does not require aged bamboo as other products like bamboo flooring and plywood. However it is envisioned that an integrated industry will developed with demand for aged bamboo as well and in future properly managed bamboo plantations are the long term solution to a secure supply for the production of sticks and other bamboo products.

3.4.2. Raw material volume requirements

According to utilization rates for high processing technology outlined in Table 3, typical consumption rates for one production line over the first three years of operation are set out in Table 4. It is assumed that production line capacity will gradually increase over the early years of production.

Table 4 - Raw material consumption

	Year 1	Year 2	Year 3
Expected output of dried finished products for 1 production line (tons/year)	100	150	225
Raw material consumption for 1 production line (tons/ year)	357	536	804
Production line capacity utilization	40%	60%	90%

At a target sustainable yield of 20t/ha in the long term, such an operation would require in the order of 40 to 50 ha of well managed plantation for supply.

⁶ John Marsh Consultant report for GIZ, July 2012 “ Strategies for Bamboo Industry Development in Varin District, Siem Reap Province Cambodia”.

In addition to supporting businesses, GIZ and its government and other partners will work with farmers, to help them to develop sustainable forest management techniques, based on best practice developed in China. This will further assure the provision of long-term quality supply.

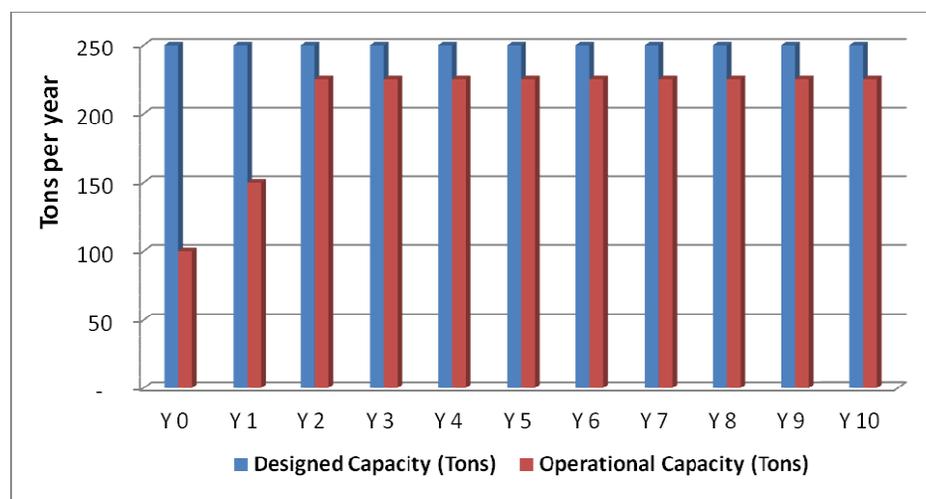
4 Investment Plan and Financial Analysis

4.1. Investment plan

In order to illustrate potential investment performance and to support planning and budgeting, this section sets out an investment plan and financial analysis for a typical bamboo sticks investment. The model assumes the end to end investment in and operation of a mixed and flexible sticks processing line established in Varin district, Cambodia, located close to suitable supply of raw materials. It recommends a flexible sticks production line, meaning that product output can be modified to suit specific market and buyer opportunities. It assumes the manufacturing process set out in Section 3 above and machinery as set out in Annex 1. This analysis can be tailored to meet the specific investment scale and expectation, the market conditions and business management capabilities.

Based on bamboo sticks production lines in China and Vietnam, the nominal output capacity is 250 tons per year of finished bamboo sticks production, which is based on one operational shift per day and 300 working days per year. To allow for operational inefficiencies and market demand fluctuation, it is assumed that the 'true' capacity will reach only 90%, and will grow gradually during the first few years of operations. The financial model for expected returns therefore takes into account a realistic production capacity and associated sales in the first few years of the investment. Figure 2 below shows how the output capacity is expected to grow throughout the first ten years of the investment, based on observation of manufacturing capacity in China and Vietnam.

Figure 2 - Target production output capacity



4.2. Financial analysis

This section sets out the financial analysis of the investment, including some key profitability indicators derived from standard financial modeling approaches, data collected from Vietnam and China as well as input variables observed from Varin District, Siem Reap and Cambodia. This encompasses the end to end investment including workshop building, procurement of equipment, technology transfer and ongoing operations. The analysis shows that the investment is financially feasible with Internal Rate of Return up to 123% along 10 years of investment project and an achievable payback period of two years and four months.

4.2.1 Capital expenditure

The Table 5 shows the planned capital expenditure for a mix and flexible bamboo sticks investment for one production line.

Table 5 - Planned capital expenditure

Investment items	Unit	Quantity	Cost (\$US)
Land	m2	600	0
Building	m2	300	12,000
Machinery and equipment	Set	1	31,718
Technology transfer	Set	1	5,000
Total			48,718

A major part of the capital expenditure is workshop building and machinery, which must come with appropriate infrastructure such as electric power and roads. Machinery and equipment represents 65% of total capital expenditure and simple workshop building represents 25%. A further 10% of the capital expenditure has been allowed for technology transfer, which investors should consider as a critical factor to produce quality products, manage operations in efficient manners and reduce risks. This is assumed that workshop land is secured and supported by government at low cost or zero cost.

4.2.2 Market selling price

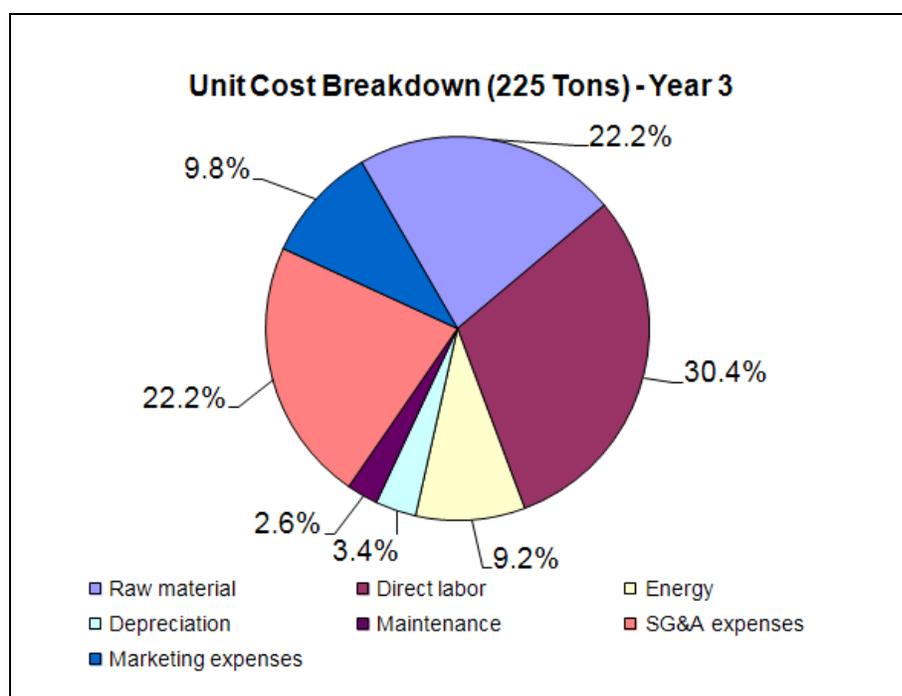
In the major countries producing bamboo sticks like China and Vietnam, the current exwork price of disposal chopsticks and barbecue sticks is ranging from US\$ 800 to US\$1,000 per ton in Vietnam and from US\$ 1,120 to US\$ 1,250 per ton in China. The wholesale price of these items has been measured to range from US\$ 1,170 to US\$ 1,270 per ton in Siem Reap province and around Cambodia. There is a healthy domestic market in Cambodia for chopstick and toothpick; plus there is also a huge demand for bamboo chopstick and barbecue sticks in the international markets. Cambodia's domestic demand for chopsticks and toothpicks; and world demand for all kinds of bamboo sticks (especially chopsticks, barbecue sticks and incense sticks) are growing while supply is limited to specific country producers; therefore we forecast the selling prices of bamboo sticks to grow over the coming years.

Since Cambodia can compete with China, Vietnam and other countries on the price of raw materials and on the cost of labor, it is possible to price Cambodian bamboo sticks very competitively against international markets. Furthermore, at the start of operations, it may be necessary to price the new product competitively to attract interest from international and domestic buyers. Therefore, for the purposes of this analysis a conservative price estimate of US\$850 per ton of finished products has been assumed. In reality, Cambodian sticks producers will have the flexibility to increase pricing in line with demand, thereby increasing profits and reducing the pay-back period of the investment.

4.2.3 Unit cost structure

Figure 3 below shows the unit costs breakdown in year 3 of the investment, which illustrates the cost structure, key input costs and therefore opportunities for cost management. Bamboo raw materials, direct labor; and sales and administration are the three major input costs. This illustrates the importance of maximizing utilization of bamboo material, efficiency of management and direct labor productivity.

Figure 3 - Unit Cost Breakdown - Year 3



4.2.4 Income statement

The income statement report is extracted from financial model and provides an illustration of how the business would be expected to perform in terms of income and expenditure. This assumes income tax rates relevant to Cambodia whereby investors are exempted for the first 5 years of the project. The corporate income tax costs are assumed to 25%.

Table 6 - Income statement projection (Unit: 1,000 USD)

Year	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Revenue	85	134	210	220	231	242	254	267	279	293	307
COGS	43	58	78	82	87	93	98	104	111	117	125
Gross Profit	42	75	133	138	144	150	156	162	169	176	183
SG&A	33	37	43	46	49	47	50	54	57	61	65
EBITDA	9	38	89	92	95	102	106	109	112	114	118
Depreciation	5	5	5	5	4	4	4	4	4	4	1
Interest expense	1	2	2	1	1	0	0	-	-	-	-
EBT	3	31	83	86	89	98	102	105	108	111	117
Income Tax	-	-	-	-	22	24	25	26	27	28	29
NOPAT	3	32	82	86	68	74	77	79	80	83	87

4.2.5 Balance sheet

The balance sheet shows the stability of the investment in terms of assets and liabilities across the term of the investment. In order to achieve this balance, the model has assumed increasing extraction of significant yearly dividends, which amount to a total of US\$ 499,000 across the project life. In summary, the financial simulation reflects a rapid increase in the value of assets as a result of project operation and cash security.

Table 7 - Balance sheet projection (Unit 1,000 USD)

Year	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Cash	2	29	84	131	204	252	305	358	416	476	538
Receivables	7	11	19	20	22	23	25	27	29	32	34
Inventories	1	3	5	5	6	7	7	8	9	9	10
PP&E (Netbook value)	44	39	34	29	24	19	14	9	5	-	-
Total Assets	54	82	142	185	256	301	351	402	459	517	582
ST liabilities	-	-	-	-	25	28	30	30	32	32	34
LT liabilities	16	12	10	6	4	1	-	-	-	-	-
Equity	38	70	132	179	227	272	321	372	427	485	548
Total Liabilities	54	82	142	185	256	301	351	402	459	517	582

4.2.6 Profitability indicators

Table 8 below shows the key profitability indicators of the investment. As shown, the project is highly profitable with an internal rate of return (IRR) up to 123% and the average of

EBITDA/Revenue ratio of 37.0%. The ROE throughout the project life is 38.7% on average. The payback period is predicted to two years and four months.

Of course, the actual performance of the investment will vary depending on how the investment is implemented, the investment strategy and on the dependencies and assumptions on inputs and outputs of the production process.

Table 8 - Profitability indicators

Indicator	Index	Unit
EBITDA ⁷ Margin (= EBITDA / Revenue) (10 year average)	37.0	%
Net Profit Margin (= NOPAT ⁸ / Revenue) (10 year average)	28.2	%
ROE - Return on Equity (10 year average)	38.7	%
ROA - Return On Asset (10 year average)	34.7	%
IRR - Internal Rate of Return	123	%
NPV - Net Present Value (20% discount rate)	0.35	Million USD
Payback Period	2.3	Years

4.2.7 Dependencies and assumptions

In this financial analysis, the following assumptions were made:

- Product portfolio:** The financial model simulates on a mix and flexible sticks production line, which covers a portfolio of wide range of bamboo sticks including chopsticks, barbecue sticks, toothpicks, incense sticks and mat sticks. This could help to maximize business opportunities in sticks sectors and reduce risks face to low demand in single product. The investor also can adjust easily production line to be specialized and focused on profitable market segments regarding to market situation and competition.
- Output price:** The assumed sales price of bamboo sticks is US\$850 per ton regardless type of sticks. The prices of toothpicks and incense sticks would be higher; of course these require higher quality of bamboo material and additional workforce. The price is increasing in line with CPI of 6% per year. A higher price may be achieved by improving product quality,

⁷ Earnings Before Interest, Taxes, Depreciation and Amortization

⁸ Net Operating Profit After Tax

obtaining product certification, showing benefits of sustainable raw bamboo supply and forest management or providing positively social and environmental impacts.

- **Bamboo raw material:** The assumed bamboo price is US\$30 per ton of fresh quality bamboo at the factory gate. It also will be increased by a basic CPI 6% per year. After 10 years it will increase by 79% in nominal terms.
- **Labor cost:** Labor expenses are assumed to increase 159% in nominal terms in the year 10 of project, by an annual increase of 10%.
- **Capital expenditure:** The costs of fixed assets, construction is assumed to US\$30 per square meter for workshop, drying rooms and warehouse; land is assumed as a support from government at low cost or zero cost. The amounts would of course vary in each specific project upon production scale and the availability of infrastructure. Equipment and machinery costs are based on the manufacturing process set out in Annex 1 and quotations received from Vietnamese equipment suppliers in October 2012.
- **Other input factor costs** are assumed to grow in line with the CPI, which is 6% higher after 1 year and 79% higher after 10 years. A detailed explanation of these assumptions can be found in the investment financial model developed by the consulting team.
- **Financial status:** The overall financial status will depend on various factors including financial structure, interest rates, dividend mode, short term accounts and liabilities management, depreciation, management style and business strategy.

4.3. Risk management

Like any other investment project, there are numerous factors that could impose significant impact on business performance such as:

- Unexpected increasing or decreasing in output price.
- Unexpected increasing or decreasing in bamboo price.
- Unexpected low selling volume due to low market demand or competition or any circumstances effecting production capability like power supply, bamboo supply shortage, labor, which results in the factory operating at only at 50% of designed capacity.

Various scenarios (if other inputs are unchanged)	ROE (%, average)	IRR (%, average)	Net Profit Margin (%, average)	Revenue (1000 USD /year, average)	Payback period (years)
Base case (price US\$ 850 per ton)	38.7	123	28.2	229	2.3
Product price increases to US\$ 950 per ton	42.1	179	33.6	256	2.0

Product price decreases to US\$ 700 per ton	28.7	64.2	17.2	189	3.5
Operation at 50% of capacity	17.8	36.7	8.2	134	5.0
Bamboo price increased by 25%	38.3	97.8	24.3	227	2.8

As shown above, the factor that has the greatest impact on profit and project performance is the operation capacity derived from various external elements. The key profitability indicators still show positive earnings when workshop operates at only 50% of designed capacity. In this event the investor may consider maximizing diversity of the product portfolio and find the solution to reduce production cost (or increase labor productivity) to get competitive price for not only domestic market but competitive price in the international market. Then, the investor should find ways to integrate into distribution channels in domestic markets or link production to overseas markets with own capacity or through export agents.

In other circumstances, the project shows highly positive earnings even if selling prices decrease by 18% to US\$ 700 per ton of finished product or bamboo material price is increased by 25%.

Like other projects, the profitability can be affected by other potential risks such as changes in interest rates, raw bamboo quality, new alternative technology or advanced machinery.

In order to manage and reduce risks, the following activities are recommended:

- a) **Technology:** We strongly recommend an appropriate investment in technology transfer from major bamboo sticks producer countries like China and Vietnam from the outset. Bamboo stick production requires uncomplicated technology but there is a fast development in machinery and equipment which can result high productivity and product quality improvement. Investors should bundle technology transfer with equipment, and should not simply seek the least expensive piece of stick processing equipment. Equipment set-up, training and after sales support should be included in the equipment supply. There are many cases of failed bamboo factories because investors chose the wrong supplier and included inadequate technology transfer services.
- b) **Bamboo supply:** While there are sufficient resources in the early years of production, Businesses should collaborate with authorities and GIZ to establish a sustainable bamboo supply program. If there is not a sustainable bamboo supply plan, the business will face difficulties with bamboo raw material supply following several years of production. Further, plantation development will enable expansion in future from a minimum scale bamboo processing investment.
- c) **Product and market diversification:** To reduce the risks of producing a single product to the market, investors should consider the benefits of a flexible production capacity, exploiting diverse market opportunities in various stick products by setting up a flexible production

line. This also can help to maximize bamboo material utilization rate and increase production line performance. Furthermore, the investors should consider integrating vertically into distribution channel and export bamboo sticks to overseas customers.

- d) **Labor force:** This is not a big scale investment, but bamboo sticks are labor intensive product and the labor force is an important factor for success. The factory will operate in the remote areas where only unskilled labour is available. The labour force will probably not be familiar to industrial manufacturing. Investors should consider technical training for both technical and management employees.

below shows how key profitability indicators are affected by the changes of each the above factors.

Table 9 - Analysis of profit sensitivity with different assumptions

Various scenarios (if other inputs are unchanged)	ROE (%, average)	IRR (%, average)	Net Profit Margin (%, average)	Revenue (1000 USD /year, average)	Payback period (years)
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ANNEX 1: Bamboo Sticks Manufacturing Process

A flexible production line for bamboo sticks is described here. The major steps and machines can produce chopsticks, barbecue sticks, incense sticks and mat sticks, while production of toothpicks and thin sticks require additional equipments at marginal investment.

It is noted that this report analyses and simulates a flexible production line to produce diverse kinds of sticks. Investors can adapt and employ this model for single product investment in specific investment purposes.

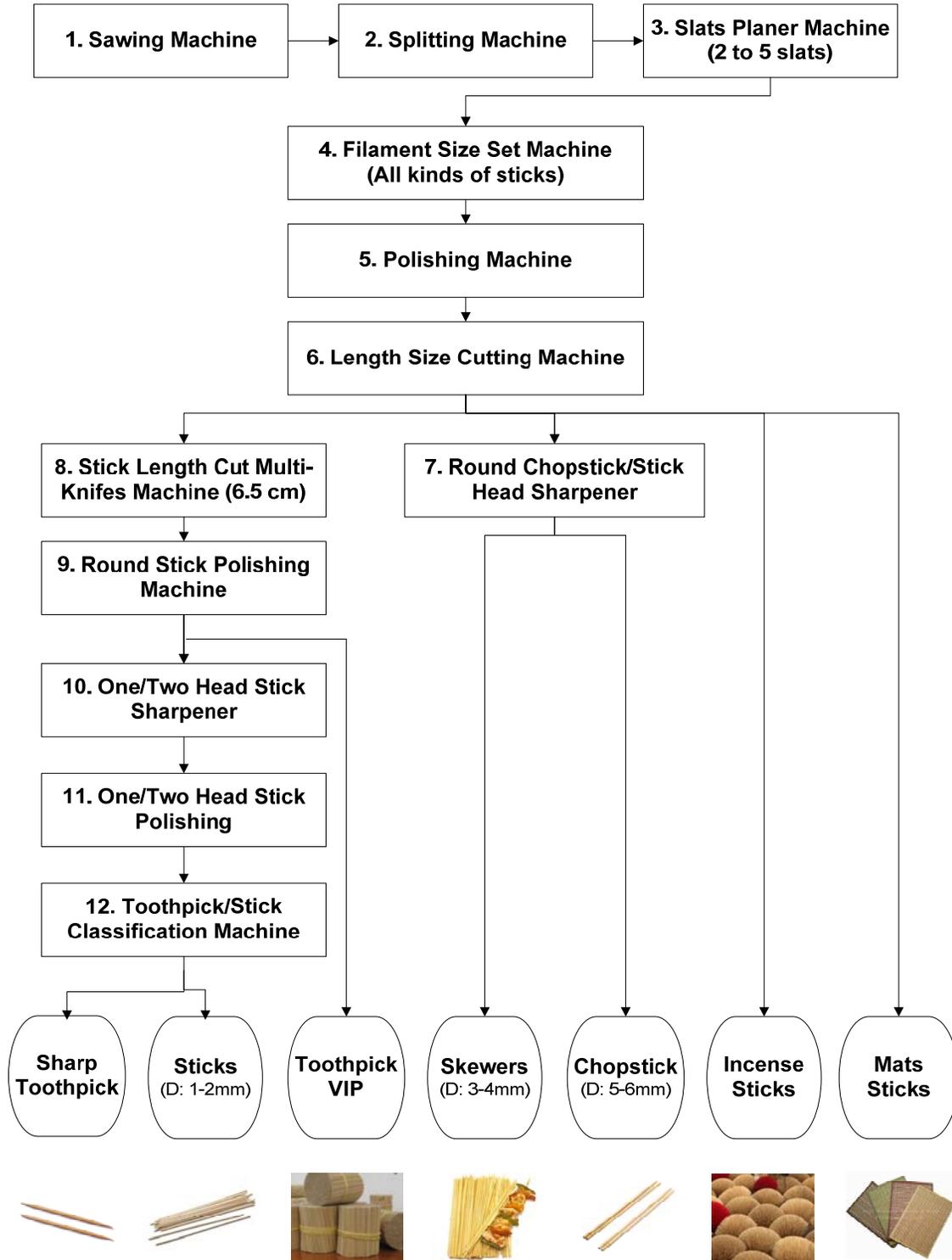
Figure 12 describes the manufacturing process and equipment. In practice, the process should include some additional tasks such as annealing and drying materials or bactericidal treatments

The main phases of the production process for bamboo sticks are as follows:

1. Bamboo Sawing
2. Bamboo Splitting
3. Slats Planer (2 to 5 slats)
4. Filament Size Set Machine (All kinds of sticks)
5. Polishing Machine
6. Length Size Cutting
7. Round Chopstick/Stick Head Sharpener
8. Stick Length Cut Multi-Knives Machine (6.5 cm)
9. Round Stick Polishing
10. One/Two Head Stick Sharpener
11. One/Two Head Stick Polishing
12. Toothpick/Stick Classification
13. Toothpick/Stick Arrangement

Figure 4 - Sticks Manufacturing Process and Equipment

Sticks Manufacturing Process and Equipment



1. Bamboo Sawing

After selection, bamboo culms are cut into fixed-length poles.



2. Bamboo Strip Splitting

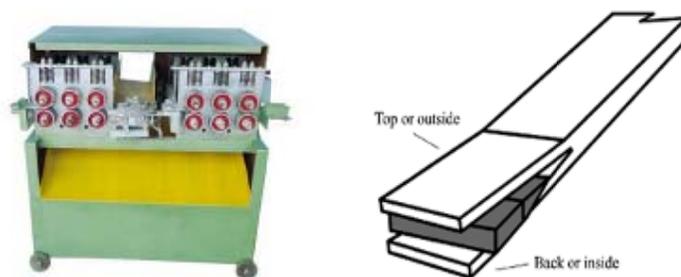
This cutting machine is simply designed. After cutting into poles, these are slated into strips by hand or using splitting machine as show in the figure below.



Normally this process takes place in the primary processing workshop as bamboo culms need to be processed as soon as possible because it is easier to split fresh culms. Bamboo strips will be transported to main sticks production line for further processing if main processing site is located far from bamboo resources. It may prove simpler to transport split or semi-processed culms than whole culms, but this will be decided in each case.

3. Slats Planer

By this step, the green layer and inner layer of bamboo strips are removed, strips with two parallel flat sides – called ‘slats’ are produced. Slats should be further split into thinner slats with thickness varying from 1.0 to 6.0 mm depending on kind of products these slats will be used to produce. To make chopsticks, the output slats should be 5.0 or 6.0 mm thickness while toothpicks require slats of 1.0 mm thickness. Russei Prey has wall thicknesses up to 20mm thick over the bottom sections, so multiple slats maybe produced from this thickness



4. Filament Size Set Machine

The filament size set machine will lathe bamboo slats into round long sticks with fixed diameter of the same diameter of finished product. Through this machine, a flat slat will be lathed into 3 or 4 round sticks depending on width of bamboo slats and diameter of sticks, furthermore number of round sticks output depends on knife grooves.



5. Polishing Machine

The polishing machine helps to remove hairs on bamboo round sticks and make sticks smoother.



6. Length Size Cutting Machine

This machine is used for cutting long round sticks into required length of finished products, mostly chopsticks, barbecue sticks, incense stick, mat sticks. Except toothpick will be further cut by Stick Length Cut Multi-Knives Machine in the step 8.



7. Round Chopstick/Stick Head Sharpener

The stick head sharpener will saw heads of round fixed length sticks to produce chopstick and barbecue sticks.



8. Stick Length Cut Multi- Knifes Machine (6.5 -12 cm)

The below machines will cut long sticks into fixed length toothpicks / sticks with multi knives.



9. Round Toothpick/Stick Polishing Machine

This polishing machine is similar to polishing machine of the step 5 but it's specifically designed to polish toothpicks.



10. One/Two Head Stick Sharpener

The below machine will lathe one or two head of toothpicks.



11. Toothpick/Stick Polishing

The toothpicks will be polished again by this machine to make heads of toothpick smoother.



12. Toothpick/Stick Classification and Arrangement Machine

This machine is used for arranging toothpicks and facilitates packaging.



13. Packing Machine



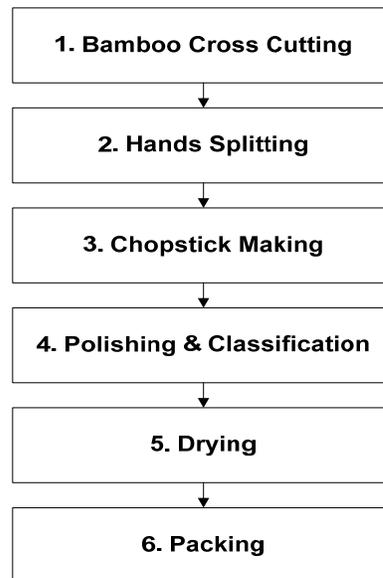
14. Blade Sharpening Machine



ANNEX 2: Low Processing Technology Model

The low technology model only can be used for producing bamboo chopsticks and skewers of low and medium quality, because the manufacturing process is really simple; and machinery and equipment are modest.

1. Manufacturing Process and Equipment



There are only two key steps in this manufacturing process: 1/ Bamboo Cross Cutting; and 2/ Chopsticks Making.

a) Bamboo Cross Cutting



b) Bamboo Making (Sharpening)



2. Supply bamboo for fine chopsticks production

This section describes an observation and calculation of conversion rate of bamboo utilization. As mentioned, the low processing technology results in low utilization rate of material; furthermore it creates a high volume of waste and residue.

No	Index	Weight (kg)	Rate/ 1kg fine chopsticks	Percentage (%)	Note
1	Average weight / Culm	24.0	9.6		
2	Raw chopsticks weight	4.5	1.8	18.8	Raw chopsticks/ culms
3	Dried and scraped chopsticks weight	2.7	1.08	11.3	Scraped chopsticks/ culms
4	Finished chopsticks	2.5	1	10.4	Finished chopsticks/ culms
5	By-products and consumption weight	19.7	7.9	82.2	By-product chopsticks/ culms
	- Node dust	6.8	2.7	34.5	Each By-product/ total by-product weight
	- Chopsticks dust	5.7	2.3	28.9	
	- Consumption (moisture, sawdust)	7.2	2.8	36.6	

Source: Production data of Ha Long co-operative in Thanh Hoa province, Vietnam, October 2008.

3. Fine chopstick production scale

The below table shows data of one chopsticks factory working under low processing technology, observed and measured in Thanh Hoa province, Vietnam in October 2010. Currency rate VND/USD in 2008 was 16,000/1. Number of working days per month is 25.

No	Index	Unit	Quantity	Unit price (US\$)	Total (US\$)
1	Raw material				
	Dendrocalamus Barbatus culms/	Culm	800		

	day				
	Dendrocalamus Barbatulus culms/ month	Culm	20,000		
2	Product (Finished Chopsticks)				
2.1	Productivity / day	Kg / day	1,800		
2.2	Productivity / month	Kg / month	45,000		
3	Machines and Accessories				41,691.00
	Chopsticks press machine	Machine	7	438.00	3,066.00
	Chopsticks dried oven	Oven	3	6,250.00	18,750.00
	Screening machine	Machine	1	500.00	500.00
	Head chopsticks broaching machine	Machine	7	1,875.00	13,125.00
	Packaging machine	Machine	5	1,250.00	6,250.00
	Number of workers / day	Person	64		

According to above data, the cost of machines and equipment was valued at US\$41,691.

Comments:

- The above data presents an observation of one fine bamboo chopsticks factory at medium large scale investment, which used 7 head chopsticks broaching machines, 3 drying ovens and produce 1,800 kg of dried finished product a day.
- The factory employs 64 workers.
- This is a typical model of fine chopsticks production, easy to replicate and take into place at different output volumes by installing a required number of machines and equipment in production line.
- This business model is useful for implementing a small scale investment, for example a 50% of production capacity of the case with limited capital expenditure.
- Rate of utilization of bamboo is very low: Finished chopsticks/ Fresh bamboo culms = 10.4%.
- This risk of this model is that it only can produce a limited portfolio of products, mainly chopsticks and skewers. It might be a constraint if the market size for the output is limited or the market of chopsticks and skewers jump into high competition.
- It is highly recommended that investors in such business model should consider a residual business model to exploit by-products. The Annex 3 will presents a description of a business model for residues produced from main chopsticks production for reference.

ANNEX 3: Low Scale Bamboo Chopsticks and Skewer Investment Options

This section presents options for investors to consider and choose investment scale in the context of Varin district, Siem Reap province, Cambodia.

The first option with minimum investment costs around US\$ 10,000 for machines and equipment, which can produce up to 250 kg of finished chopsticks or skewers per day. This option requires processing of 3,000 kg of fresh bamboo culms per day.

Second option requires processing of 6,000 kg of fresh bamboo culms per days, which results in production of 500 kg of finished chopsticks and skewers a day. This investment plan costs around US\$ 20,000 in machinery and equipment.

I	Machines and Accessories	Unit Cost (US\$)	OPTION 1		OPTION 2	
			No Machine	Amount (US\$)	No Machine	Amount (US\$)
1	Bamboo cross cutting	337.00	1	337.00	2	674.00
2	Chopsticks press machine	500.00	2	1,000.00	6	3,000.00
3	Chopsticks size cutting	577.00	1	577.00	2	1,154.00
4	Polishing machine	962.00	1	962.00	2	1,924.00
5	Head sharpen chopsticks / skewers machine	1,683.00	1	1,683.00	3	5,049.00
6	Packaging machine	2,019.00	1	2,019.00	2	4,038.00
8	Drying equipment	2,885.00	1	2,885.00	1	2,885.00
	Total Investment		8	9,463.000	18	18,724.00

II	Production Scale	Unit	OPTION 1	OPTION 2
1	Bamboo consumption / day	Kg	3,000	6,000
2	Productivity / day	Kg	250	500
3	Productivity / year	Kg	75,000	150,000
4	Turnover / year	US\$	63,750	127,500
5	Income / year (estimation)	US\$	15,000	30,000

* Note:

1. Above costs of machinery and equipment are exclusive of VAT 10% and some transportation expenses.
2. With conservative profitability indicators in the general financial model, we expect annual net income from such investment plans can reach 23-25%.

ANNEX 4: Bamboo Residue - Bamboo Powder and Bamboo Pellets

Bamboo Powder

Bamboo powder is produced from bamboo plant and bamboo pieces by grinding bamboo material in a controlled process to produce powder of specific size properties. Bamboo powder is for a valuable use for bamboo waste produced in the production of slicing bamboo poles, sanding bamboo planks. Where markets can be identified, bamboo powder is valued at around \$100/t, while bamboo wastes, used for energy production will be \$10/t in the context of Varin. (\$40/t in Phnom Penh where dried biomass/wood has a higher value).

Bamboo powder is widely used in various industrial processes as a filling additive. Bamboo powder is used as a bulking agent in plastic composites, outdoor decorative materials, heat insulation, moisture absorption materials, fire-resistant coating, high-grade building materials, fire-proof panels, chemical additives, plastics additive, incense sticks and more. General specifications of bamboo powder is shown in below table:

Items	Specification
Product name	Bamboo Powder
Granularity	20-300 mesh
Ash	≤2%
Moisture	≤6%
Colors	Deep brown, light brown, natural white, bleach white.

Should a buyer be found for such materials in Cambodia, bamboo grinding equipment could be purchased to convert waste into powder.

Bamboo Biofuel Pellets

Bamboo, like wood, was mainly composed of hemicelluloses, cellulose and lignin. It had great potential as a bio-energy resource of the future.

Bamboo pellets are reliable, cost-effective and environment-friendly source of energy for home heating systems. Bamboo pellets are produced from recycling bamboo powder and bamboo stalks after production of other bamboo products, by crushing the bamboo into powder and pressing together for pellets milling.

General specification of bamboo pellet is described in below table:

Items	Specification
Product name	Bamboo Pellet
Density	1,200 - 1,300 kg/m ³

Diameter	6-8 mm or 60-90 mm
Length	10-12 mm or 50 cm
Calorie	4500-4800KCAL/KG (18.8-20MJ/kg)
Moisture	8 - 10%
Ash Content	Standard 0.9% - 1.1%
Color	Natural bamboo color

There are various technological options and machinery capacity to produce bamboo pellets. In this report, we introduce a simple technology requiring limited machinery and investment, which, we think, is convenient to small scales of investment in combination with other bamboo processing investment.

Manufacturing Process

The manufacturing process of bamboo powder and pellets is described as below:

Bamboo Chips and Sawdust as inputs	
Bamboo Milling	
Drying	
Crushing	
Bamboo Powder	Bamboo Pellet Injection
	Bamboo Pellet

Manufacturing and Machinery List

1. Bamboo milling



Bamboo Waste



Bamboo Milling Machine

2. Drying

Bamboo waste and chipping need be dried to make lower moisture content. High moisture will make bamboo powder moldy and swearing. After drying, moisture of bamboo is from 6% to 16%.

3. Bamboo crushing

Bamboo waste will be sent into the crushing machines to make big bamboo chips into very small powder, this powder size is from 20 mesh to 400 mesh, depending on the usage of next production.



Bamboo Crushing Machine



Bamboo Powder

4. Bamboo pellet injection

Under high pressure, bamboo powders will be mixed and pressed into pellet pieces, the size of pellet depends on machine type and pressure capacity.



Bamboo Pellet Injection Machine



Bamboo Pellets

Equipment Cost Summary for Bamboo Pellets

No	Items	Production Capacity	Investment Cost (US\$)
1	Pelletizing	200 kg/hour	2,933.00
2	Bamboo chopping		865.00
3	Drying equipment		2,404.00
	Total		6,202.00

Note: Price of bamboo crushing machine is exclusive in the above investment plan

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