INTERNATIONAL NETWORK FOR BAMBOO AND RATTAN
(INBAR)

TRANSFER OF TECHNOLOGY MODEL
(TOTEM)

THE BAMBOO FURNITURE MAKING UNIT

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TRANSFER OF TECHNOLOGY MODELS (TOTEMS)

Transfer of Technology Models (TOTEMs) are focussed educational tools providing relevant information and distance training on one specific area of bamboo/rattan management, processing or utilization. They are a means of technology transfer between similar regions throughout the world, with the emphasis on South-South transfer for livelihood development. They enable those involved in the management and use of bamboo and rattan resources to more efficiently and effectively develop and use skills relating to these resources.

TOTEMs are primarily intended as practical information resources and teaching aids for those at the local extension level in their communities, who can utilize them to assist local community development. Each TOTEM consists of a detailed written report of the technology, a PowerPoint presentation, a film, and, where relevant, a set of technical photographs. They also include information on target users, financial analyses of sample set-ups from the partner country preparing the report and information on where to source particular technologies (such as equipment). The TOTEM thus provides all the information required for establishing similar technologies within interested countries and regions.

- The **report** contains all the technical details of the particular processes involved, as well as other relevant information for establishing the technology such as costs of business establishment, running costs and cash flows.

- The **PowerPoint** presentation contains details of the relevant technologies and their applications, and is intended to provide an overview of the potential of the technology for development.

- The **film** provides a visual guide to the processes involved and helps to bring them alive in the minds of the learners.

The different parts of the TOTEM are targeted at slightly different audiences, via the local extension workers. The report and film are intended to be the main means of extension to the individuals and communities who will implement the technology and who will directly benefit from it. The PowerPoint presentation is primarily intended as a tool for the extension worker to sell the technology and its role in development to those who provide the infrastructural, policy and financial support for its implementation, such as government departments, donors and NGOs. There is considerable flexibility, however. Local extension workers will be able to incorporate the TOTEMs in their own work as they wish, and will be able to adapt and develop the TOTEM to suit their particular requirements and conditions.

This TOTEM on the **bamboo furniture manufacturing unit** has been produced by Zhang BinYuan and Jiang JingYan at Nanjing Forestry University, China. The report part of this TOTEM describes the technology for establishing and running a bamboo furniture making unit for rural development in regions where bamboo is available as a raw material. It is intended to be used in conjunction with the illustrative film included in this TOTEM package

The first part of the report introduces the technology, discusses its development attributes, its benefits and it's applicability. The second part of the report provides detailed information on the technical aspects of producing laminated bamboo furniture. **Appendix I** lists the equipment required by the unit and its costs. **Appendix II** gives information on the input costs for producing a sample set of furniture.

This TOTEM is one of the first to be produced by INBAR/ NFU and your feedback is most welcome - kindly contact INBAR or NFU with your comments or suggestions.

Note 1: This TOTEM has been edited at INBAR and differs slightly from the form in which it was received from the authors.

Note 2: All calculations are in Renminbi (RMB). At the time of writing RMB 8.25 = USD$ 1

LAMINATED BAMBOO FURNITURE AT-A-GLANCE

What is Laminated Bamboo Furniture?

Laminated bamboo furniture is a relatively new type of furniture but is similar to laminated wood furniture. Bamboo can be used to produce chairs, sofas, bookshelves, cabinets and tables and is widely regarded as an excellent substitute for wood.

How is it produced?

Bamboo culms are split into longitudinal sections that are then coated with glue. These are bonded together in shaping jigs to produce different component parts. These are assembled into sub-assemblies and then into the furniture. The furniture is finished by sanding, lacquering and polishing.

What is the market for laminated bamboo furniture?

The market for laminated bamboo furniture is growing steadily. Presently, China is the only place it is produced on even a medium scale and there is much potential, particularly in exports to more affluent countries. It is produced from a renewable resource and is environmentally friendly which can be an important selling point, and it is also so versatile that a huge range of designs and products can be produced.

What is the role of a laminated bamboo furniture-making unit in rural development?

A laminated bamboo furniture unit will provide income-generating opportunities for local people. The requirements for a regular supply of bamboos will encourage the establishment and sustainable management of bamboo stands and plantations to supply a regular quantity of bamboos to the unit and hence create income-generating opportunities for bamboo cultivators and harvesters. The need for efficient management of the unit would offer significant opportunities for career enhancement and employee empowerment if run by the community as a cooperative.

How do I establish such a unit?

The unit requires a considerable amount of machinery and equipment the total costs of which are estimated at USD $ 35, 000. This represents a significant investment and is ideally suited for establishment as a community-run cooperative venture. Strong forwards and backward linkages would be needed to make the venture a success and some trained management personnel would be desirable in the early stages.

PART ONE

INTRODUCTION

DEVELOPMENT ATTRIBUTES, TARGET GROUPS and BENEFITS of a

BAMBOO FURNITURE MAKING UNIT

1. Introduction to laminated bamboo furniture

Laminated bamboo furniture is a modern invention but has already become popular in many countries. It is produced from moulded bamboo components and to the uninitiated eye the furniture is unrecognisable as having been produced from bamboo. A huge range of furniture can be produced, such as tables and chairs, bookshelves, beds, cabinets and recliners. The furniture is durable, practical and has a modern appearance. In recent years elegant designs have been produced in China and Japan.

2. General development attributes and advantages

The main development attributes of the technology are as follows:

- Creates a significant number of employment opportunities.
- Increases community welfare.
- Promotes the efficient management and use of natural bamboo resources.
- Reduces dependency on timber wood and hence helps conserve tree wood.
- Increasing plantations of bamboo can bring degraded land back into productivity.

The main advantages of the technology are:

- Permits the formation of modern, ergonomic shapes and designs of furniture.
- Careful design can continue to improve the product and innovative designs will maintain and develop market presence.
- A wide range of surface finishes can be achieved.
- The furniture is highly durable.
- The mechanical properties of bamboo are better than those of timber wood for furniture.

3. Suitable agro-ecological regions

The unit may be established in any bamboo-growing region of the world. The unit requires a supply of relatively large bamboos and so tropical and subtropical regions are more suitable as these areas are natural habitats of larger-culmed species. Moso bamboo (*Phyllostachys pubescens*) is ideal for producing laminated bamboo furniture and can be grown in frost-free sub-tropical and temperate regions. Many clump-forming types are also suitable, and these are found in subtropical and tropical regions. Bamboos are very good for restoring degraded lands and reducing soil erosion, and new plantations could ideally be established in areas of abandoned shifting cultivation land or steep slopes in high rainfall areas to supply the unit and bring unproductive land back into productivity.

4. Target groups

There are two target groups. The first are those who will be employed in the unit. The unit will require unskilled, semi-skilled, technically trained and management personnel and many of these people can be recruited from the local villages. Staff with skills in marketing and design will also be required. There will be many opportunities for training and skills upgradation of existing staff. The second group are those who cultivate and harvest the bamboo raw materials for the unit who will benefit from the increased demand for culms.

5. Benefits

The unit will create employment and income-generating opportunities for a wide range of people and will improve the economies of the rural communities in which is established. The income generating potential of the unit is considerable because of the high level of value addition the processing imparts, and indeed if established as a community cooperative venture and well run, the community should benefit considerably. Increasing the area of bamboo stands and improving management practices will benefit the local environment and the local people - bamboos can be intercropped with food crops and so increase food security. Alternatively they may be intercropped with pot plants for extra income generation.

6. Requirement for success

The essential requirements for a successful laminated bamboo furniture-making unit are:

- Regular supply of bamboo culms
- Start-up capital of USD $ 35, 000 - 40, 000
- Land of up to 1 hectare (includes some for future expansion)
- Business plan
- Market links
- Secure labour force

Concluding remarks

The laminated bamboo furniture unit is a relatively large-scale venture requiring a considerable amount of start-up capital and a number of experienced personnel. By innovating new designs and seeking out new markets the unit will be able to develop rapidly and there are significant opportunities to open up export markets for laminated bamboo furniture in more affluent countries. The unit can easily be established at the community level, ideally as a cooperative venture. But, in view of the scale of investment required it may be preferable to establish the unit with the assistance of state agencies or NGOs to ensure the venture is successful and the community are the true beneficiaries.

PART TWO

THE LAMINATED BAMBOO FURNITURE MANUFACTURING UNIT

1. Introduction to the unit

Laminated bamboo furniture is produced by splitting rectangular sections from bamboo culms that are glued together in jigs to produce sub assemblies. These are then assembled, additional fittings are added and the furniture then finished with lacquer or other coating. A laminated bamboo furniture unit should therefore consist of a number of different sub-divisions, each specialising in one particular aspect of production. The particular processes involved in producing laminated bamboo furniture are outlined in the next section.

2. Production of laminated bamboo furniture

Raw materials

Bamboos with large culms and thick walls are ideal as they maximise the number of sections obtained from each culm. Moso bamboo (*Phyllostachys edulis*; (Carr.) H. de Lehaie) is most commonly used to produce laminated bamboo furniture in China. Its culms are straight, about 10-20 meters tall with DBH-diameters of 8-20cm and wall-thickness of 0.4-1.5cm. Note that other species with similarly dimensioned culms would be equally suitable. In China these include green sulphur bamboo (*Phyllostachys sulphurea* var. *Viridis* R. A. Young), broadflower dendrocalamus (*Dendrocalamus latiflorus* Munro) and Chinese thorny bamboo (*Bambusa sinospinosa* McCl.).

To ensure normal growth of the bamboo forest and maintain the quality of furniture produced, it is necessary to consider the harvesting age and season of the bamboo culms. Usually, only mature bamboo is harvested. Moso bamboo culms are harvested when they are 5-9 years old. Culms of clump forming bamboos (such as broadflower dendrocalamus and Chinese thorny bamboo) are harvested when 3 or 4 years old. The structural properties of immature or older culms render them unsuitable for furniture making.

Technical process

Generally, five workshops are required within the unit to manufacture laminated bamboo furniture. They are:

- Section preparing workshop
- Laminated blank-making workshop
- Unit shaping workshop
- Assembling workshop.
- Finishing workshop.

The technical processes of laminated bamboo furniture manufacturing are shown in Table1.

Table 1 The technical processes of manufacturing laminated bamboo furniture

Preparing bamboo sections	Cross-cutting bamboo culm, width sizing, rough planing, boiling, coloring, air drying, kiln drying, precision planing, grading;	
Making laminated blanks	Linear blank	Roller glue spreading, edge glue spreading, assembling sections, hot pressing, cooling;
	Curved blank	Plane glue spreading, edge glue spreading, assembling sections, moulding, heating and curing;
Unit shaping	Linear units	Datum plane planing, datum edge planing, opposite plane(edge) planing, tenon cutting, mortise drilling, surface dressing.
	Curved units	Marking out, curve sawing, datum plane (edge) planing, opposite plane (edge) planing, tenon cutting, mortise drilling, shaping, surface dressing.
Assembling	Assembling components, assembling products	
Finishing	Surface treatment, painting, coat curing, paint film dressing.	

2.1 Preparing bamboo sections

2.1.1 Cross-cutting

After removing branches and tips the culms are crosscut into short lengths with a cross cutting saw.

2.1.2 Culm splitting

Culm sections are split using a two-disk gang saw into splits 35 mm wide.

2.1.3 Rough planing

The bamboo split is curved in cross section. However the laminating process requires a rectangular cross-section so a rough planer is necessary to remove the nodes, the green epidermal layer and produce strips with a rectangular transverse-section.

2.1.4 Boiling

Many manufacturers find it helpful to improve the sections resilience to insect and fungal attack by soaking the strips in water vats and boiling or steaming them. Generally, some

chemicals, such as sodium carbonate or hydrogen peroxide solution, are added to the water. At a certain temperature, borers and their eggs and microorganisms will be killed. Moreover, some chemical components such as starch on which borers and microorganisms depend will be dissolved or decomposed. The time and temperature requirements for preserving will vary according to bamboo species and desired heat penetration. Most manufacturers boil strips at a temperature of 100^0C for at least 24 hours. In addition boiling also increases the moisture content of the core of the sections, which is beneficial to further air-drying and kiln drying. Also, internal stress in the strip will be release while boiling.

2.1.5 Coloring

Some customers prefer bamboo products with light to deep brown coloration. These colors can be produced by steaming the strips in a pressure tank, which is heated by steam. At certain temperatures, some chemical components (e.g. lignin) will deepen their color. The higher the temperature and the longer they are steamed, the deeper the color they take on. Usually the section will take on a chestnut-color at a pressure of 3-5 kg/cm^2 for 90-105 minutes.

2.1.6 Drying

The moisture content of boiled or steamed strips is about 100%. It is generally desirable to dry the bamboo before use because dry bamboo is stronger and less susceptible to degradation (biological, thermal or chemical) than wet bamboo. Furthermore shrinkage and swelling are directly related to moisture content such that that dimensional changes in service depend directly on the magnitude of the moisture content change the bamboo undergoes. Far greater dimensional changes would ultimately occur if the bamboo were not dried before being used. Ideally, the bamboo should be dried to the equilibrium moisture content corresponding to service conditions before being used in secondary manufacturing processes. Wet bamboo cannot be glued effectively, treated well with preservatives, or painted.

Bamboo sections are either air-dried, kiln dried or both. Air-drying requires no special equipment and thus it is simple and cheap. It only requires reasonably favorable weather conditions and land. In air drying, strips are stacked into units that are then placed in the air yard. The time necessary for air-drying depends upon the weather. Also air-drying can reduce the period of kiln drying by 24-40 hours, and save kiln-drying energy.

Air-drying does, however, have many major disadvantages. Since the weather cannot be regulated, there is little control over the drying process and it is much slower than kiln drying. Many drying conditions are such that the moisture content of the bamboo strips cannot be reduced below about 12%, the equilibrium moisture content of most locations. So, kiln drying is necessary for final drying. With kiln drying, strips are placed in a

drying kiln. A modern-kiln is simply a large chamber in which the air movement, temperature and relative humidity are controlled. This control permits the drying rate to be both regulated and accelerated. The strips can also be dried to any desired final moisture content. Drying in conventional kilns is accomplished using a series of temperature and relative-humidity conditions designed to be mildest when the sections are wettest. The series of combinations of desired air temperature and relative humidity is known as the kiln schedule. As the moisture content changes the schedule is made progressively more severe. Once all the free water has been evaporated the strip becomes less defect-prone and kiln conditions are further intensified to increase the rate of drying. Kiln drying time depends upon the bamboo species, the kiln and the schedule being use. Superior grade bamboo products require a final moisture content of between 6 and 10%.

2.1.7 Precision planing

The sections have excellent dimensional stability after drying.. At this time, they can be planed to the required thicknesses and widths. A precision planer is the ideal machine for this. It is equipped with four blades, two horizontal and two vertical, and can plane all four surfaces of each strip at the same time to predetermined dimensions. It also smoothes the surface.

2.1.8 Grading and classification.

The planed sections may still have some defects such as blue stains, sawing marks, veining, dents and ripples. They must be visually graded by individuals who have been trained to gauge the magnitude of the defects. High quality furniture requires chromatismless faces and backs. That is, the color of the sections it is composed of should be the same on both sides. Thus, they must be classified into face strips, core strips and back strips.

2.2 Making laminated blanks

Furniture is made from laminated units that are usually divided into “linear” or “curved” units and these are shaped from linear or curved blanks respectively. The methods and equipment used to make linear or curved blanks are different and are introduced below:

2.2.1 Linear blank making

2.2.1.1 Glue spreading

Adhesive is spread on the plane and edge surfaces of the graded and classified sections. The most common adhesive in the laminated bamboo industry is urea-formaldehyde resin. It is produced synthetically from urea and formaldehyde, and it hardens or cures

under heating or pressing. When curing, urea-formaldehyde resin goes through chemical changes that make it waterproof and impervious to attack by microorganisms.

The glue is applied to the sections using a variety of techniques including roller spreaders, spraylines, curtain coaters and brushes. Each of these techniques has its advantages and disadvantages, depending upon the type of manufacturing operation under consideration. Roller glue spreaders are employed in most factories because of their low price, efficiency and stability.

2.2.1.2 Assembling sections

Sections are assembled (laid up) into laminated blanks immediately after application of adhesive. This must be done rapidly and carefully. Speed in assembly is necessary because the glued sections must be placed under pressure within certain time limits or they will dry out and become ineffective. Careful workmanship is required to lay up the face, core and back strips correctly.

2.2.1.3 Hot pressing

Assembled units are loaded into the hot press, where hydraulic rams press the assembled units in two directions, horizontal and vertical, exerting a pressure of 1.2-1.4 MPa. The temperature of the hot press is usually set in the range 100-165^{0}C.

2.2.1.4 Cooling

After hot pressing, many mills post-press the units. This is performed in a cold press which consists of one stationary platform and one connected to hydraulic rams. The load is held under pressure for several hours to maintain the shape and dimensions of the unit.

2.2.2 Curved blank making

2.2.2.1 Glue spreading

The adhesive and the method of application are the same as for linear blanks.

2.2.2.2 Assembling and moulding sections

Curved units are formed in moulds that are usually made of steel with many screw bolts on the center of mould. The sections are assembled in the mould and the nuts are tightened to press the blanks into the shape of the mould. Finally the blanks are struck to improve bond strengths between the edges of the sections.

2.2.2.3 Heating and curing

The loaded moulds are then transported to the heating chamber, where the blanks are heated and the curing process of the adhesives is accelerated. The heating time depends upon the dimensions of the blank and the temperature in the heating chamber. Usually, the blanks can be unloaded from the moulds after being heated at 60^0C for 24 hours, but they must be left in the heating chamber to allow further curing of the urea-formaldehyde resin and maintain their shape and dimensions.

2.3 Unit shaping

2.3.1 Shaping linear units

A linear blank has four surfaces and two ends. Usually, the two surfaces with larger area are called planes, and the other two are called edges. The first step of blank shaping is to plane the datum plane surface, on which the dimensions of subsequent processing and assembling will be based. A hand fed planing machine is most common is used to plane datum planes. The datum edge can be planed in the same machine. Then, the opposite plane and edge are planed in the thickness machine.

Today, more and more manufacturers employ multiple-cutter moulders to plane the datum plane and opposite plane at the same time. These are similar to the precision plane mentioned above, but are more precise.

2.3.2 Shaping curved units

The process of shaping curved units differs from that of linear units.

First, curved lines or patterns must be mark out on the unit according to the design chosen. A plate of the required final shape is useful for marking out the patterns on the blanks.

Secondly, the unit is sawn to the lines marked on it with a narrow-band saw with a blade 20-40 mm wide.

Thirdly, the datum edges are planed in a hand-fed planer.

Fourthly, the blank is shaping in a spindle-moulding machine. Usually, a mould is applied to hold and form the shape of the curved blank.

2.3.3 Forming mortises and tenons

Laminated bamboo furniture is divided into frame-furniture and panel-furniture depending on the way it is assembled. Frame-furniture is joined together with mortise and tenon joints. Tenons can be formed with a tenoner, which is an efficient, precise machine for cutting tenons, or by two circular saws. When circular saws are employed to cut tenons, the two ends of the blank must first be cut precisely by vertical saw, and one of them then chosen as the datum. Secondly, tenon shoulders are cut in the same saw according to the datum, and finally the tenon-cheeks are cut with a horizontal circular saw. Mortises are formed with a woodworking drill or a mortiser.

2.3.4 Surfaces dressing

The purpose of surface dressing is to remove milling marks, glue and other imperfections from the surface. Wide-belt sanders, belt sanders, disc sanders, or portable power sanders are used to sand the surfaces of blanks to obtain smooth, flat surfaces. In some cases, a decorate planer can also be employed to dress surfaces.

2.4 Assembling

The assembling process includes assembling components into sub-assemblies and sub-assemblies into final products. Individual units are first assembled into subassemblies, and these are then assembled into the final product. During assembly glue and clamps must be used to securely fix the parts together.

2.5 Finishing

The standard finishing system necessary for a fine bamboo furniture finish includes: bleaching, prestaining, staining and coloring, wash coating, filling, sealing or wash coating, glazing, topcoating, rubbing, polishing and cleaning.

- Bleaching removes color from the bamboo. It is necessary for very light and medium-light or honey-colored finishes. Bleaching is also done when the natural color of the bamboo is to be changed.

- Prestaining is necessary when using natural bamboo strips in which the color variation is great.

- Staining adds color to the bamboo and emphasizes the grain. It is also done to change the tone or shade of a bamboo surface.

- Wash coating prevents the stain from bleeding into the filler and provides a hard surface on which the filler can be applied.

- Fillers add color and close the pores of the bamboo. The filler is sometimes eliminated to give the bamboo an "open-pore": appearance.

- A sealer or wash coat is applied over the filler to prevent color from bleeding into the finish.

- Glazing is the application if a coat of thin, transparent finishing material over filler or sealer to give a highlighted, shaded, or antique effect.

- A varnish, synthetic, or lacquer finish can be applied as a topcoat after all coloring and filling has been completed.

The usual steps in finishing open-grained bamboo products are detailed below. For a lighter or honey-toned finish, it is necessary to bleach the bamboo before prior to the finishing process. For medium to darker finishes, this procedure below should be followed:

1. Apply a thin glue size mixed in water. Allow to dry. (The purpose of the glue size is to make sure the thin, hairlike bamboo fibers are held down or held up so that they will be removed when sanded). Sand the surface well with 3/0 (120 grit) garnet paper. Clean thoroughly with a tack rag.

2. Apply water stain and allow it to dry thoroughly. Sand lightly with 3/0 (120 grit) garnet paper.

3. Apply a wash coat of shellac or lacquer sealer. Allow it to dry three to four hours then sand the surface with 5/0 (180 grit) garnet paper.

4. Apply colored filler with a brush. Work it into the grain using a circular motion, forcing the filler into the pores. Then wipe across grain with burlap to remove excess filler. Next wipe along the grain with a fine cloth, using light strokes, to even up the surface. Allow to dry overnight.

5. Apply a sealer coat of shellac or lacquer, allow to dry, and sand with 6/0 (220 grit) or 7/0 (240 grit) garnet paper.

6. A glaze can be applied over the sealer to give a highlighted, shaded, or antique effect.

7. Apply three coats of lacquer and allow sufficient drying time between each coat. Sand lightly.

8. Rub to a light sheen with pumice stone and water or paraffin oil.

9. Rub with a good paste wax and polish.

3. Costs and profitability

For a brief economic summary, we can take a sofa set as an example. This includes a triple sofa, two single chairs and two tea tables and costs RMB 2600 (USD $315) to purchase in the shops. It is produced by Zhejiang Jianan Bamboo Products Co. Ltd. The plant is located in Anji County in the northwest of Zhejiang Province, southeast China. The costs of the equipment used to manufacture laminated bamboo furniture is shown in **Appendix I**.

The total coat of the furniture includes bamboo culms, water and electricity power, finishes, salary, cutting knives and so on (**Appendix II**). This comes to RMB 1602.

Thus the pre-tax profit made on the furniture, not including start-up costs is

2600-1602 = **RMB 998** (or 39%)

APPENDICES

Appendix I

Equipment used to manufacture laminated bamboo furniture in Jianan

Equipment	Working Dimension (mm)	Motor power (kW)	Overall dimension (L×W×H mm)	Price (RMB)
Cross-cutting saw	300	1.0	3000×650×850	2,000
Fixed-width cutter	250	2.2	6000×650×910	3,360
Rough planer	42	10.4	2320×550×1010	28,000
Crane(set)	9000	3.4	12,000×9000×550	8,000
Boiler(set)	2T			30,000
Boiling vat (set)			3000×1200×1500	8,000
Coloring tank *			1100×4000	20,000
Drying kiln (set)			3000×2700×2100	30,000
Precision planer	42	12	2250×960×1150	31,200
Roller glue spreader	643	2.2	9100×7200×890	5,000
Hot presser	1900×1400	9.5	2300×1700×3400	8,800
Moulds (set)				9,000
Heating chamber(set)			3000×2700×2100	4,500
Surfacer (Hand feed planer)	443	2.8	1250×620×870	3,500
Thicknesser	489	3.4	1320×820×930	4,600
Narrow-band saw		2.1	1015×940×1720	2,900
Spindle moulder		3.4	1278×1160×870	13,000
Precision cutting saw (vertical)	300	1.9	1400×1230×2017	3,000
Precision cutting saw (horizontal)	300	1.9	1400×1230×870	3,000
Driller	20	1.6	650×674×1986	3,800
Turning sander	300	1.4	720×540×860	2,000
Wide-bled sander	700	10.5	3200×900×1450	25,000
Disc sander	200	1.6	640×570×890	2,000
Clamp (set)				2,000
Air spray finishing (set)		0.6		1,5000
Measurement tools				5,000
Sharpening machine		0.4	750×800×1400	2,000
Other				32,000

Total 289,460

(US$35, 000)

*Note that he life-span of a tank made of ordinary steel is only 2 years, but that a stainless steel tank may last more than 5 years.

Appendix II

Total costs of producing a sofa set

Item	Cost (RMB)	Notes
Bamboo culms and glue	640	
Water and electricity power	90	Water can be pumped from rivers and wells.
Finish	220	
Salary	530	
Cutting knives	35	
Package	20	
Other	67	Tax, supervisor's salary, office cost, flowing capital and interest, equipment depreciation, etc.
Total	1602	

(USD $194)