A Business Model for a Red Oak Small Diameter Timber Processing Facility in Southwest Virginia

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Abstract

The conversion of red oak small diameter timber (SDT) into solid wood products was investigated. The objectives of this research were to 1) determine the yield of lumber, pallet and container parts, and residues from SDT and the market potential for these products; 2) determine the economic feasibility of a SDT sawmill and pallet part mill located in Southwest Virginia; and 3) develop a business plan for a SDT sawmill and pallet part mill located in Southwest Virginia. The methods for this research consisted of resource, yield and economic analyses, and the development of a business model. The resource analysis indicated an ample supply of red oak SDT available in Southwest Virginia. The yield analysis used red oak SDT logs, which were manufactured into lumber, container parts and wood residues. The yield of 3" wide container parts from cants varied from 63% to 66%. The 1" nominal lumber produced was mainly 2A and 3A, 74%, and 24% was 1 common. The economic analysis utilized break even, net present value and internal rate of return analyses to determine the economic feasibility of utilizing red oak SDT.

The results of the study indicated that the sawmill-only processing level scenario is not economically feasible given the specified conditions and assumptions. However, the results showed that the sawmill and pallet part mill, actual yield scenario at $35/ton delivered log cost is economically feasible. The hypothetical business model for Southwest Custom Hardwoods was economically feasible. The final net present value was calculated to be over $750,000 and the final internal rate of return was 11%. Future yield studies should weigh logs so that the yield of residues and solid wood products can be directly compared. Future research into the utilization of hardwood SDT should include yield studies of other species and other product mixes.

Acknowledgements

I would like to acknowledge my parents, Russell and Shirley Perkins, who have endured, supported, and hopefully enjoyed my life's circuitous journey because without their patience and love I would not have had the chance to satisfy my ceaseless desire to educate myself.

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I greatly appreciate the participating company who provided the small diameter timber; enabled us to measure the yield of the products they manufactured specifically for the project; and who provided financial information used in the analysis. The sawmill manager and part mill manager provided timely, essential advice; were easy to work with and this project could not have been initiated without their or the company's participation.

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1.0 Introduction & Literature Review

1.1.0 Small Diameter Timber Predicament

Utilization of the timber resources in the U.S. has changed over the course of its history. With a seemingly inexhaustible forest resource and comparatively small population, early industrial age timber utilization was characterized by rampant exploitation and inefficiency. As the U.S. population increased, so did the demand for forest products and fears of timber shortages catalyzed forest conservation efforts, such as the creation of the United States Forest Service's national forest system and decreased wastefulness. An incipient move towards greater efficiency from a reduced resource base available for utilization began in the early 1900’s. This trend challenged the nation and the forest products industry to develop innovative processes, products and strategies to balance supply and demand. Through research and development over the past 100 years, the industry introduced products such as plywood, particleboard, fiberboard, oriented strand board, glue-laminated timber, preservative treated lumber and timber, laminated veneer lumber, wood I-joists, parallel strand lumber and wood-plastic composites to the market. These products are evidence of the greater efficiency that can be achieved from a comparatively smaller available resource base.

The reasons for the recent recognition of small diameter timber (SDT) as a nationwide problem are as varied as its classification and characteristics. In the western coniferous forest, where the federal government owns the majority of the timberland, decades of fire suppression and lack of fuel reduction by harvesting have led to millions of acres of overstocked stands that are vulnerable to catastrophic wildfires and insect and disease attacks. The recent fires in the western U.S. have catalyzed initiatives to restore the health of forest ecosystems that require thinning and utilizing SDT in order to decrease the risk of wildfires (Babbitt and Glickman 2000). Figure 1 (Rocky Mountain Research Station 1999) shows the fire regime condition class, which indicates the departure from normal fire occurrence in forest stands, for the U.S. Condition class three, shown in red on the map, indicates the forests that have missed multiple natural fires and need mechanical thinning. Condition class two, shown in yellow on the map, indicates forests that have missed at least one natural fire and need thinning or prescribed burning, if appropriate. Condition class one, shown in green on the map, indicates forests that are close to their natural fire regime and don't need treatment. (Hann and Bunnell 2001).

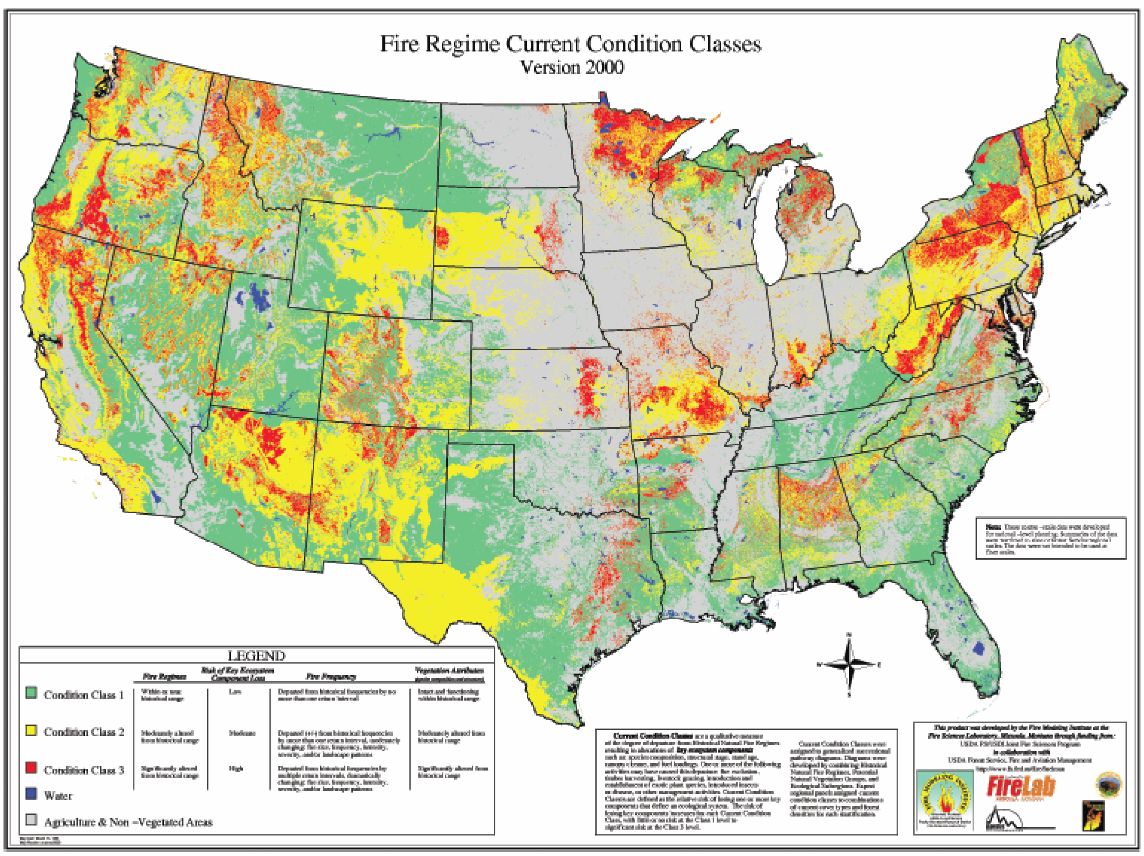

Figure 1. Fire Regime Condition Class.

According to Levan-Green and Livingston (2001), a Forest Service thinning costs $70/dry ton, however, energy and pulp markets only generate revenues of $35/dry ton. These authors suggested that utilization of SDT will require government subsidies or higher value markets in order to be economically feasible for timber harvesters and forest products companies.

In the eastern hardwood forest, where small non-industrial private forests (NIPF) are the principal forest ownership group, selection cutting is often the predominate method for harvesting timber. One motivation for NIPF owners to harvest timber is to generate revenue from their property. The largest and thus highest value timber is harvested and the smaller lower value timber resides in the stand. This practice known as high grading has occurred for decades in the hardwood forest and has resulted in more residual low value, low quality smaller timber (Nyland 1992).

In the southern industrial forest, there has been a decrease in the pulping capacity from 139,880 tons per day in 1994 to 127,390 tons per day in 2003, along with a simultaneous decrease in the production of pulpwood from 180.8 million green tons in 1994 to 162 million green tons in 2003 (Johnson and Steppleton 2003). This has led to a reduced ability of landowners to manage forest stands due to depressed pulpwood stumpage markets. The domestic demand for pulp and paper is increasingly being met with imports (Figure 2) (TradeStats Express™ 2005) which exacerbates the decline in pulpwood demand.

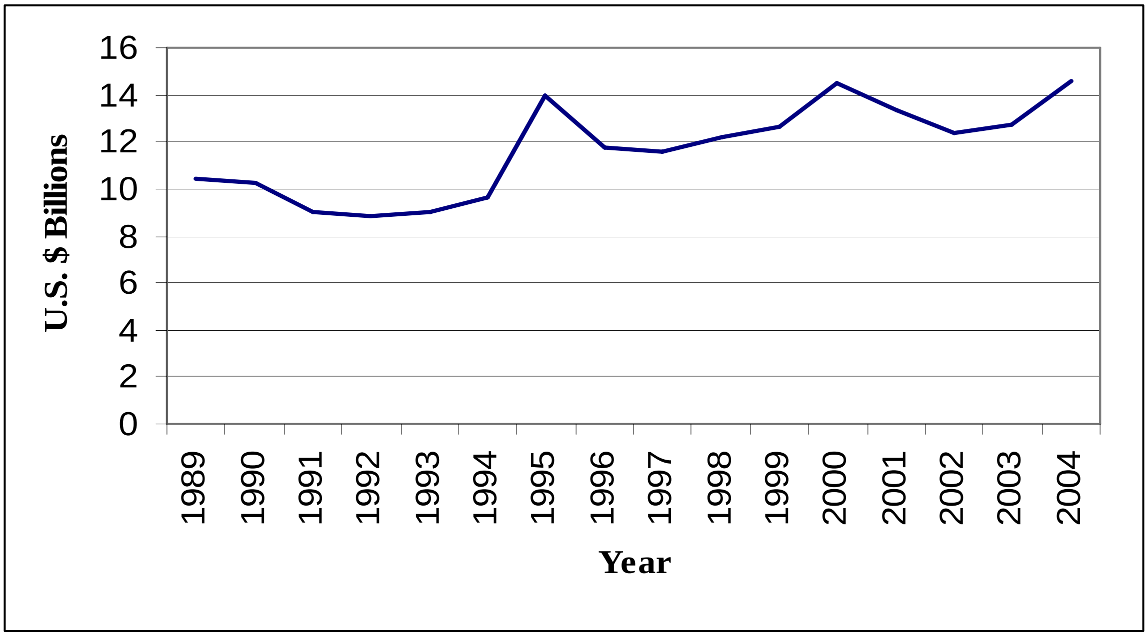

Figure 2. Imported Pulp & Paper

Throughout the U.S., public pressure to limit harvesting of old growth timber has reduced the availability of large diameter timber. The public demand for wilderness and roadless areas has decreased the amount of public forests accessible for active forest management. This has shifted the available resource base to private land and to stands that have been harvested more recently.

The demand for fiber in the production of pulp and paper represents the largest market, historically and currently, for SDT. However, as revealed earlier, pulping capacity has decreased in the South and also in the remainder of the country. The southern pulp mills account for over 70 percent of national pulping capacity (Johnson and Steppleton 2003). Clearly this concentration of demand for pulpwood in the south doesn't help alleviate the SDT problem in the west or north. Due to this demand disparity, the widespread impact of catastrophic wildfires, and the clarity of the western quandary, a large portion of SDT utilization research has focused on western softwood species. However, the focus of this research is the utilization of hardwood SDT.

1.1.1 Small Diameter Timber Classification

Small diameter timber (SDT) classifications vary depending upon forest cover type and utilization capabilities. Softwoods such as southern pine (*Pinus spp.)* with a 6” small end diameter (SED) can be utilized by softwood sawmills whereas hardwoods such as red oak (*Quercus rubra*) have a 10” SED for utilization by hardwood grade sawmills. Equipment limitations and tree species determine which timber is utilized by a particular sawmill and which timber is sent to a composite or pulp mill. Historically, standing timber with a diameter at breast height (DBH) greater than or equal to 11” has been classified as sawtimber; timber with a DBH below 11” have been classified as poletimber and timber with a DBH below 5” have been classified as growing stock.

The Forest Inventory and Analysis User’s Guide (Alerich et al. 2004) identifies three types of forest stand sizes: large diameter (greater than or equal to 11” DBH for hardwoods and greater than or equal to 9” for softwoods), medium diameter (5”-11” DBH), and small diameter (less than 5” DBH). Large diameter stands are forest stands containing 50% or more of the trees being large and medium diameter with the proportion of large diameter trees greater than the proportion of medium diameter trees. Medium diameter stands are defined as forest stands containing 50% or more of the trees being medium and large diameter with the proportion of medium diameter trees greater than the proportion of large diameter trees. Small diameter stands are forest stands with 50% or more of trees having a DBH of less than 5”.

The geographic area of this research project, Southwestern Virginia, contains predominantly hardwood timberland cover types with lesser amounts of mixed cover types and softwood cover types (USFS 2001). The majority of primary forest products manufacturers in Southwest Virginia are hardwood sawmills (Becker et al. 2001). Given the dominance of hardwood forests and hardwood sawmills in the region, the definition of small diameter timber for the purpose of this research will include both hardwood and softwood sub-sawtimber with a DBH of less than 11". Diameter ranges of SDT, specified by other research projects cited later, will also justify this classification. Figure 3 shows typical hardwood small diameter logs.

Figure 3. Hardwood SDT

1.1.2 Small Diameter Timber Characteristics

Forests, trees, and the wood products derived from them are highly variable in their characteristics. This axiom holds true for the physical traits of small diameter timber. Characteristics of SDT vary from region to region depending upon tree species, age, site class, stand history, and silvicultural treatments. Some tree species have better form and self pruning attributes than other species. SDT is not necessarily indicative of a young forest stand because it can be found in older, more mature stands. Depending upon the age of SDT it may contain juvenile wood, which is wood formed in the actively growing crown, has lower strength, and is more susceptible to dimensional instability. The same tree species may have different properties and growth rates depending upon site class. The history of natural and artificial occurrences in a forest stand will impact the trees currently within that stand. Silvicultural treatments such as thinning, pruning, and fertilization will affect the properties of timber.

Dense forest stands that have missed naturally occurring fire cycles may consist of suppressed-growth timber, which is straight, clear faced and have many growth rings per inch. Forest stands that are intensively managed as plantations may consist of fast grown timber with two or less growth rings per inch. The efficient utilization of SDT will depend partly upon the characteristics of the SDT available. This research will assume that SDT available in Southwest VA is of low quality characterized by knots, juvenile wood, crook, sweep and slow growth.

1.2.0 Hardwood Research

Hardwoods are characterized by complex anatomical structures, significant variability in physical properties both within and between species, and perceived attractiveness. All of these are desirable attributes for utilization in non-structural, decorative applications such as furniture, cabinetry, millwork, molding, and flooring. Therefore, a large portion of eastern hardwood SDT utilization research has focused on converting SDT into lumber for use in decorative applications.

The difficulty with the utilization of hardwood SDT is that it yields lower grade lumber (Hanks et al. 1980; Cumbo et al. 2004) which is often used in pallet manufacturing, as compared to sawtimber and therefore results in lower value in current markets. Luppold and Bumgardner (2003) delineated the concepts of low-value and low-grade as it applies to hardwood trees, logs and lumber. The authors reviewed volume, grade, and market changes in the eastern hardwood forest resource revealing that most of of the residual resource consists of low-grade trees containing low-grade butt and upper logs. They suggested that "low-grade material does not necessarily have to be of low-value if value-added uses and production techniques can be found."

Cumbo et al. (2003) surveyed the hardwood lumber industry to investigate trends in low grade lumber markets. According to the authors, low grade lumber markets are declining due to weak demand in the pallet and furniture frame industries. The results indicated that a majority of companies don't kiln dry their low grade lumber; there isn't a consensus in the industry on what grade constitutes "low grade lumber"; and there isn't a clear trend in the volume of low grade lumber being produced. The research showed that companies have different marketing strategies for low grade lumber in accordance to their priority levels, capital expenditures, value-added processing capabilities, and market entry attractors.

Low grade lumber utilization research can be classified into two broad areas: manufacturing and marketing. The manufacturing focus are to remove the defects that cause degrade and use the remaining lumber in a higher value product or increase the lumber yield through more efficient processing (Araman et al. 1982; Araman and Hansen 1983; Sim et al. 1991; Gephart et al. 1995; Smith and Araman 1997; Buehlmann et al. 1998 & 1999; Serrano and Cassens 1998; & 2000; Shepley et al. 2004). The marketing focus is to find out why industrial and final consumers can’t use or don’t like defects in decorative applications and then formulate product and promotion strategies to change their preferences. (Bumgardner et al. 2000; Chen-Moulec 2002; Smith et al. 2004; Wang et al. 2004). Both areas have had some success in increasing yield and market acceptance, respectively, but low grade lumber will likely be of lower value as long as current grading systems are employed. The solution to creating higher value for low grade lumber or roundwood is to find and/or create markets that don’t value the material based upon multiple grades. Pallet manufacturing is a good example of this. If a wooden part meets a minimum requirement then it can be used, if not, it is chipped and utilized in pulp manufacture or energy generation.

According to Bush et al. (2002), the amount of new hardwood lumber used in the pallet industry declined 5% between 1992 and 1999 due to increased use of softwoods and an increase in pallet recycling. The authors also described the threat of non-wood materials such as plastic, imported lumber such as Radiata pine (*Pinus radiata*), and engineered wood products, all of which will continue to displace low grade hardwood lumber being used for pallets and containers.

Cumbo et al. (2004) analyzed the lumber value and market potential of lumber sawn from oak (*Quercus spp*.) and hickory (*Carya spp.)* SDT (6”-10” SED) in Southwest Virginia. Results indicated that it may be economically feasible with current processing technology to produce lumber from 8”+ logs because wider boards and higher grades were more frequent at these diameters than at smaller diameters. Their market analysis suggested that pallet and flooring companies had the greatest capability to utilize the low grade and narrow lumber produced from SDT.

Both sawn wood markets such as flooring, pallets and ties, and composite wood markets can utilize SDT. Hansen et al. (1999) reviewed hardwood markets with respect to the utilization of SDT. They described how consumer preferences are highly variable and that barriers to utilizing SDT can be overcome.

The advent of engineered wood products (EWPs), such as plywood, particleboard, fiberboard, OSB, LVL, wood I-joists, and wood-plastic composites, was partly in response to the diminishing quantity and quality of forest resources after the “virgin” forest was utilized. The development of engineered wood composites that can utilize diffuse-porous hardwood roundwood has created a market for lower grade, smaller diameter timber.

Luppold et al. (2002) reviewed historical trends, which show increases in hardwood roundwood production and consumption in the Eastern U.S. They found that the utilization of hardwood roundwood for pulp and engineered wood products surpassed that used for sawn wood production. The authors suggested that the increase in hardwood sawtimber utilization is due to higher lumber demand and that the increase in hardwood pulpwood utilization is due to declining volumes of softwood growing stock in the south, decreased timber production on national forests and increased demand for EWPs.

Bumgardner et al. (2001) described the hardwood SDT (5-11” DBH) resource in the eastern U.S. and analyzed the industry’s rejection of the economically feasible System 6 marketing and production model developed by Reynolds and Gatchell et al. in the late 1970’s and early 1980’s. The authors described the growth of EWPs and suggested promising areas for SDT hardwood utilization research such as green dimensioning, curve sawing and rustic fencing.

Wiedenbeck et al. (2004) justified the need for hardwood SDT utilization research and reviewed trends in hardwood roundwood markets. According to the authors, hardwood lumber produced from SDT is not profitable with current practices and equipment and large portions of juvenile wood in SDT cause lumber degrade and devaluation. Their research was conducted on 8”-12” diameter Red oak (*Quercus rubra*), Black cherry (*Prunus serotina*) and Sugar maple (*Acer saccharum*) logs. Lumber grade distributions similar to but lower than those reported by Hanks et al. (1980) were reported. The authors suggested that the lower lumber grade distribution was a result of a large percentage of logs not meeting the Forest Service's grade 3 requirements.

Eckelman and Senft (1995) tested through bolt with dowel nut connectors on 6”-7” yellow poplar (*Liriodendron tulipifera*) veneer cores for use in truss systems. The results showed that roundwood members must be dried properly in order to avoid splits which decrease the strength of the joint. Eckelman et al. (2002) designed and constructed a demonstration building using 4x4's and 2x4's cut from yellow poplar SDT which were connected with round mortise and tenon joints. Their results indicated that this type of building system could be used to construct storage sheds, farm buildings, and housing in developing countries from locally available SDT, unskilled labor and low cost equipment.

Hamner et al. (2002) compared the yield of pallet parts and lumber from SDT (9"-10" SED) that was straight sawn and curve sawn. Results indicated that for logs with greater than 30% sweep deduction lumber yield improved from 48% to 60% with curve sawing. Pallet part yields from curve sawn logs were not significantly greater than straight sawn logs because the pallet parts were cut from the cant which is located in the center of the log.

The market and economic feasibility of producing dimension parts from local mill residues and SDT (8"-12" DBH) in Massachusetts was examined by Smith et al. (2002). Their research analyzed the raw material supply, manufacturing processes and equipment, and the market potential in order to develop a business plan. The results suggested that low grade lumber and SDT were the best raw material source and that a dimension plant would be profitable if operated as part of, or in conjunction with, an existing sawmill and dry kiln operation.

In summary, the majority of research on eastern hardwood SDT utilization has focused on increasing the value of low grade logs and the lumber derived from them through novel processing methods to gain better yields, and the development of character-marked decorative markets. The development of engineered wood products such as OSB, LVL, and structural composite lumber (SCL), has created markets for low grade diffuse-porous hardwoods. The increased utilization of hardwood pulpwood has also created demand for low grade hardwoods. However, the goal for forest managers, communities, forest products companies, and researchers is to find and/or create value added markets for all species of SDT that will enable economically and socially viable utilization while protecting and conserving the multiple benefits and uses that forests provided to the public and the ecosystem. A description of Southwest Virginia, its geography, people, forests, and forest products industry, will provide insight into what research is needed in order to meet that goal.

1.3.0 Southwest Virginia

As mentioned previously, the geographic area of interest is Southwest Virginia which for the purpose of this research includes the following counties that are highlighted on the map: (Figure 4): Bland, Buchanan, Carroll, Craig, Dickenson, Floyd, Franklin, Giles, Grayson, Henry, Lee, Montgomery, Patrick, Pulaski, Roanoke, Russell, Scott, Smyth, Tazewell, Washington, Wise and Wythe. For analysis of the population and employment data, the following cities are also included: Bristol, Franklin, Galax, Martinsville, Roanoke, Radford, and Salem.

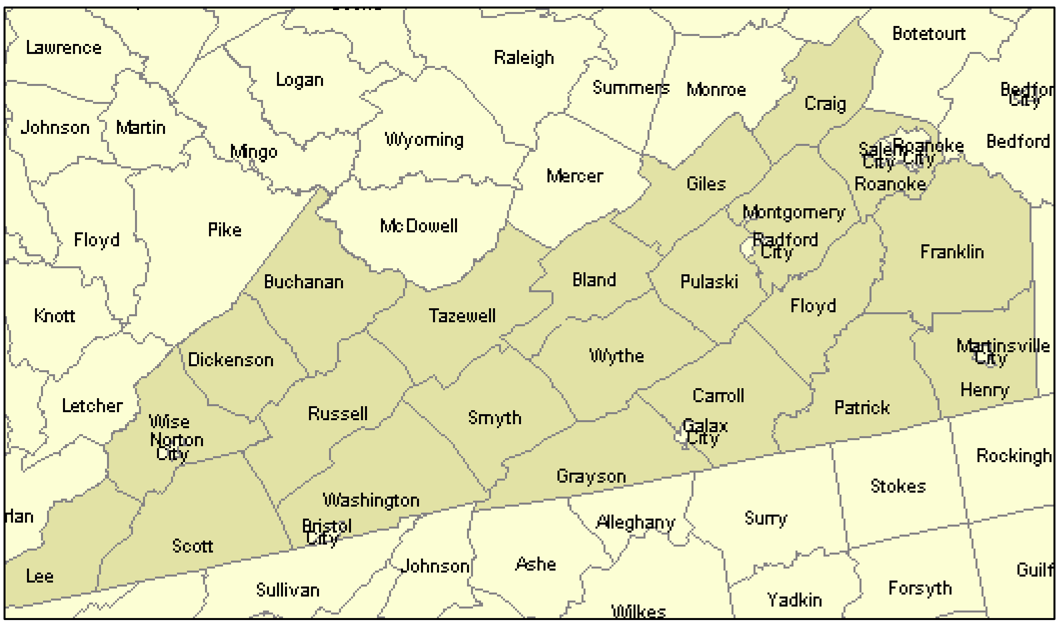

Figure 4. Southwest Virginia Map Source: National Atlas of the U.S.

This region of Virginia is characterized by mountains and valleys. Southwest Virginia has a population of over 900,000 people (U.S. Census Bureau, 2000a). Roanoke, Montgomery County and Bristol are major population centers. According to the U.S. Census Bureau, (2000b) the average unemployment rate in Southwest Virginia was 5.5% and the average percentage of people in the workforce was 56.2%, approximately 517,000, during the 2000 Census.

Approximately 65% of Southwest Virginia is categorized as forestland. There are more than 4 million acres of forestland in Southwest Virginia (USFS, 2001) with the major cover type (79%) being hardwoods (Figure 5).

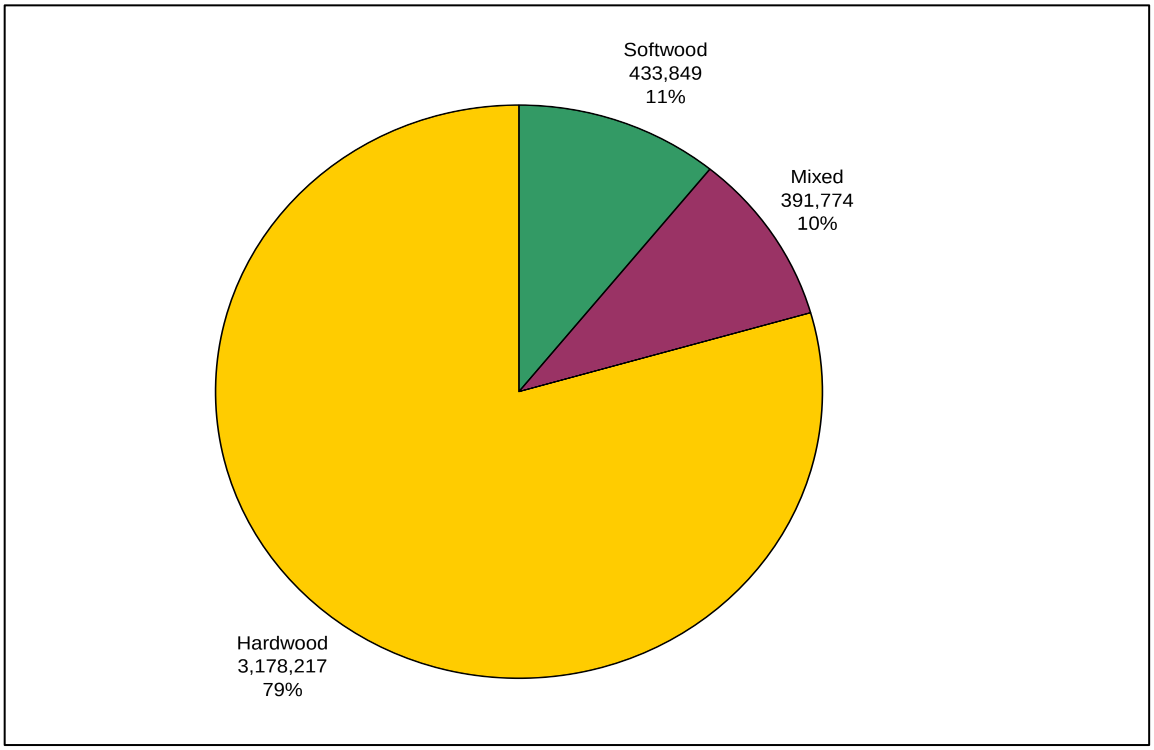

Figure 5. Forest Cover Type in Southwest Virginia

As shown in Figure 6, the majority, 82%, of forestland in Southwest Virginia is owned by private individuals. The United States Forest Service owns over 600,000 acres in this region.

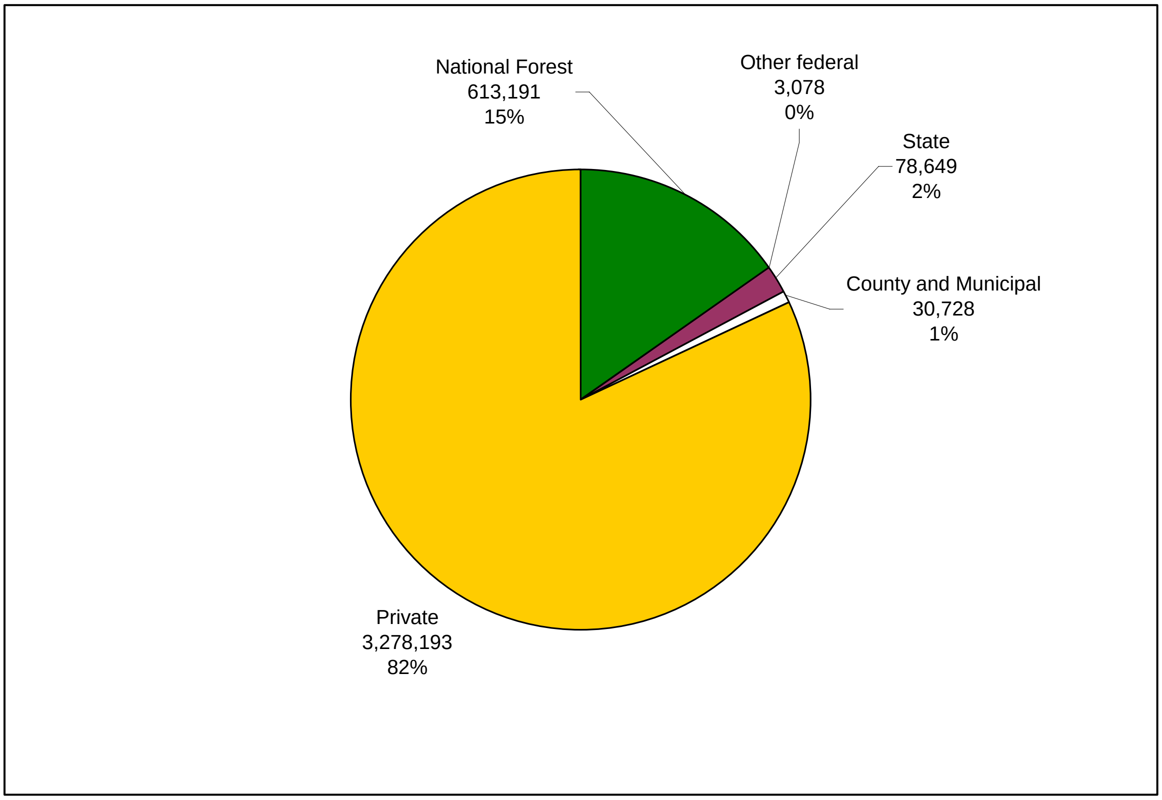

Figure 6. Forest Ownership in Southwest Virginia

The utilization of forest resources in Southwest Virginia is important to the region's economy. According to the Virginia Department of Forestry (1999), the direct economic output of the forest industry in Southwest Virginia is approximately 2.5 billion dollars. The total economic output, including indirect and induced effects, of the forest industry in the region is nearly 4 billion dollars. The Southwest region accounts for 17.3% of Virginia's forest industry's total economic output (Virginia Forest-Based Economic Development Council, 1999). However, the region contains more than one quarter of the state's forestland. This suggests that the forest has lower levels of utilization and/or forest products don't receive further value addition because of less processing (i.e.: raw materials such as lumber, logs, veneer, are transported out of the region without manufacture into final consumer goods). The total economic output of the forest industry in Southwest Virginia is shown on an individual county basis in Figure 7.

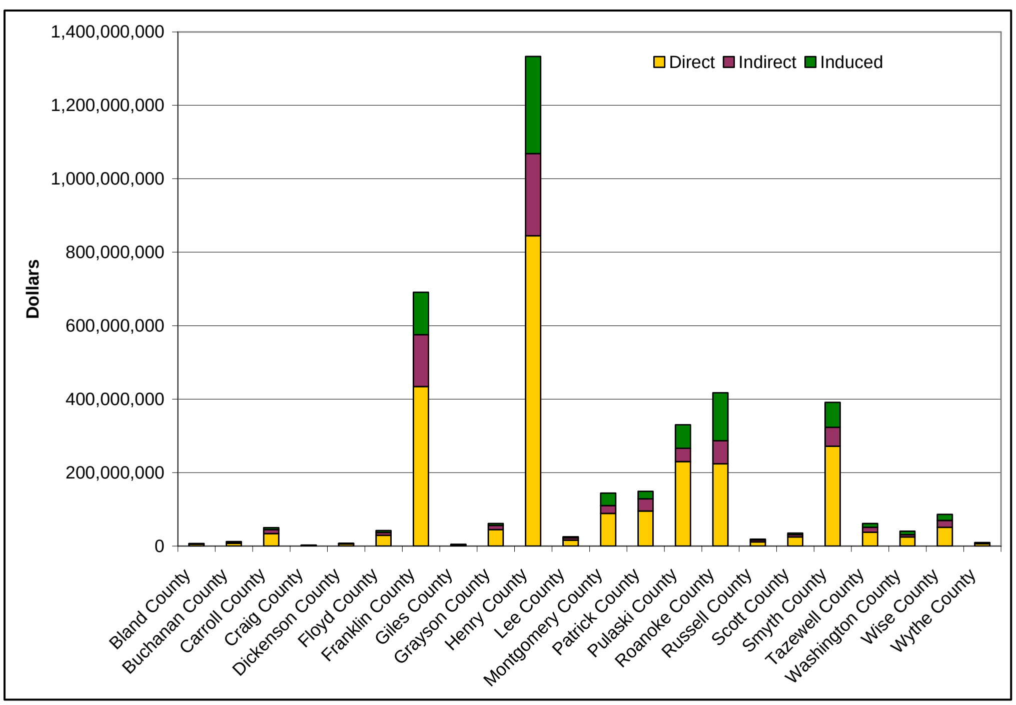

Figure 7. Forest Industry Economic Output in Southwest Virginia

Clearly, Franklin and Henry County each contribute significantly to the economic output of the region's forest industry; however, this data may be exaggerated due to the design of the IMPLAN model that was used (Virginia Department of Forestry, 1999). Historically, these two counties have had a large furniture industry, which is partly responsible for the large economic impact but this pattern has changed in recent years.

Recognition of the overall impact of the forest industry in the region is critical, but identifying current trends in the forest industry is more imperative. Forest industry employment in the region has decreased from a high of approximately 21,000 to currently 16,000 as shown in Figure 8 (Virginia Employment Commission, 2005).

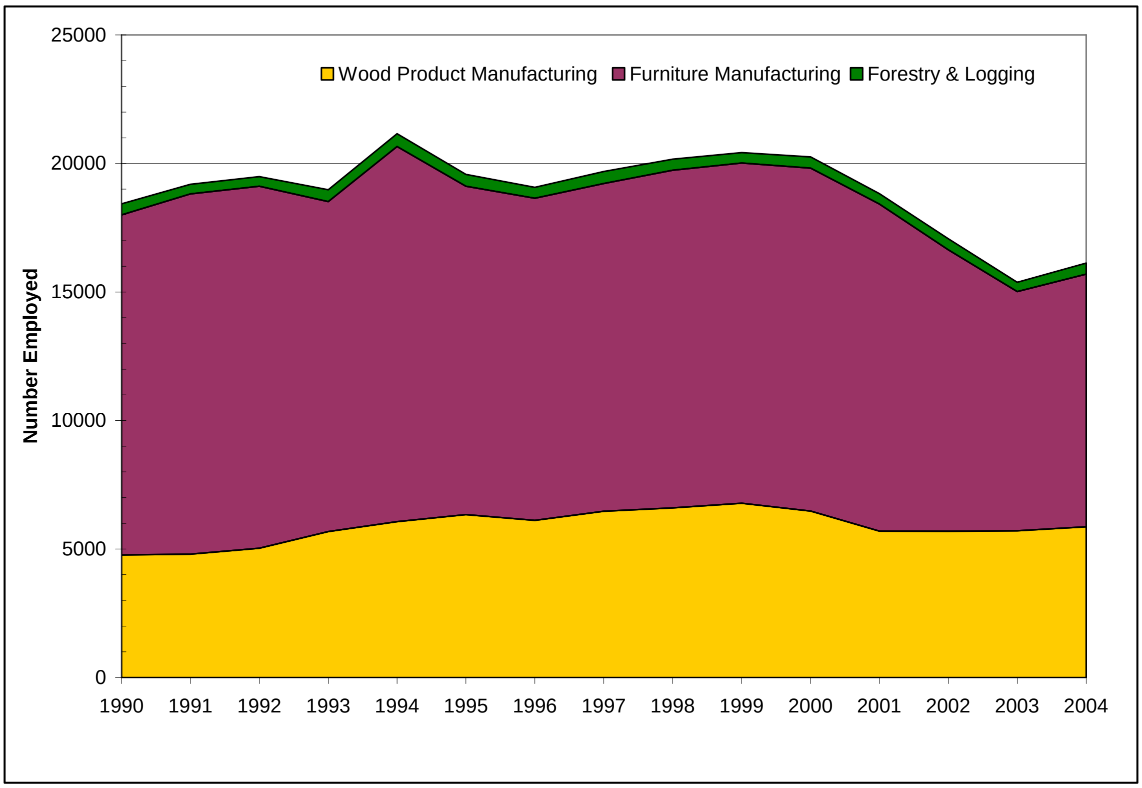

Figure 8. Southwest Virginia Forest Industry Employment.

Specifically, furniture manufacturing employment started decreasing dramatically in 2000 while wood product manufacturing and forestry and logging have remained more or less at the same level. A decrease in the secondary manufacturing base, such as the furniture manufacturing employment decline, could damage the regional economy and the wood products manufacturing and forestry and logging sectors that rely on them as industrial customers.

Despite the decline of employment in furniture manufacturing, the number of furniture manufacturing establishments has fluctuated, (Figure 9) but is greater now (118) than in 1990 (86). This trend could be caused by increased productivity, mechanization and optimization, and/or increased competition. Forestry and logging and wood products manufacturing establishments have decreased from a peak of 180 in 1997 and 156 in 1995, respectively (Virginia Employment Commission, 2005).

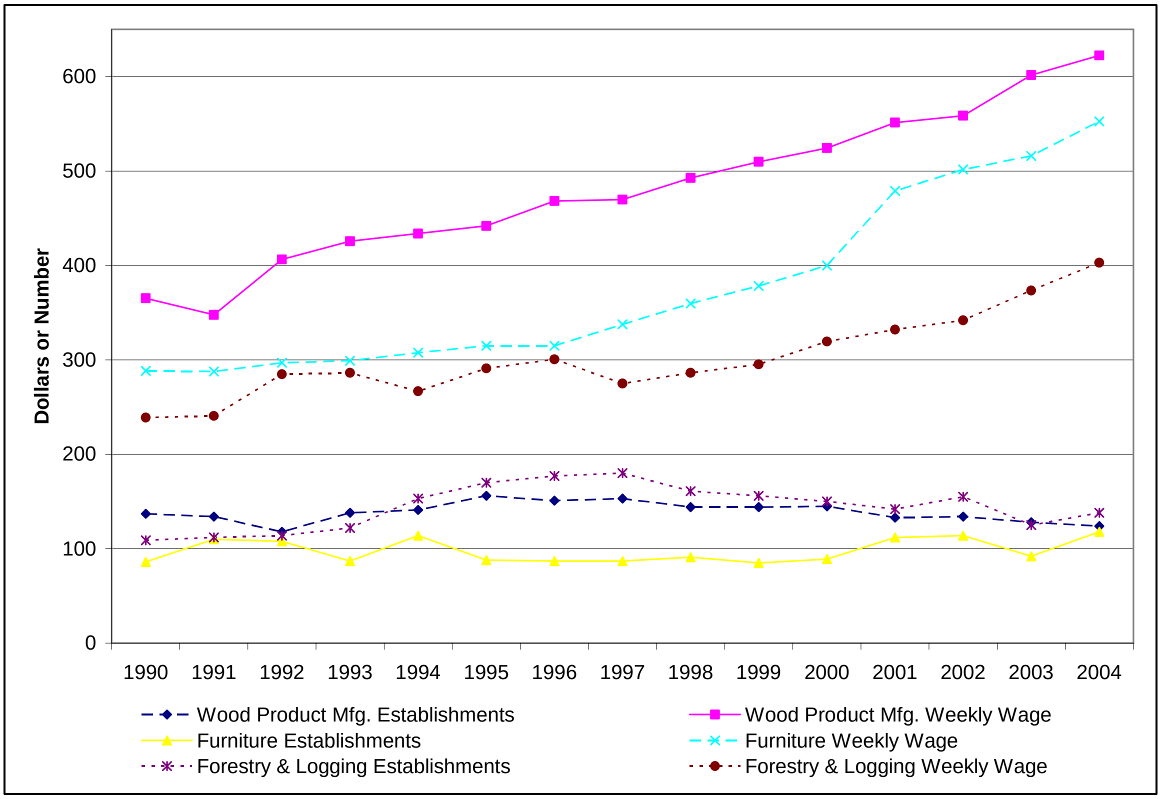

Figure 9. Southwest Virginia Forest Industry Establishments & Wages

1.4.0 Feasibility Studies

McCay and Wisdom (1984) determined the economic feasibility of nine different sawmills that could utilize SDT from Southwest Virginia. Their results showed that only two mills, a short log mill and a scragg mill, were economically feasible at an 80% operating capacity. Lin et al. (1995) used net present value (NPV) and internal rate of return (IRR) analysis to establish the economic feasibility of producing red oak dimension parts directly from grade 2 and grade 3 logs. They concluded that it was economically feasible and that their theoretical plant yielded higher profitability than sawmills. Patterson et al. (2002) used present net worth (PNW) to validate the economic feasibility of producing inside out beams from SDT at different production levels and interest rates. Their results indicated that the lowest production level, 400 stems per day, was not economically feasible, but the other two production levels, 600 and 800 were economically feasible at all discount rates used.

Spelter et al. (1996) determined the economic feasibility of lumber, engineered wood products, and pulp from western SDT using a profit/volume ratio and an investment to annual income ratio. Their results pointed out that LVL, market pulp and OSB had the best profit/volume ratios and that lumber mills had the lowest investment to annual income ratio and therefore the lowest risk. Fight et al. (2004) reported on a case analysis of a post and pole operation that utilized ponderosa pine SDT. The study revealed that hand peeled posts were the most profitable product in the operation. The authors used spreadsheets to build a model based on the knowledge of the operation's employees. Becker et al. (2004) assessed the potential costs and revenues of using a portable sawmill to manufacture lumber from ponderosa pine SDT under three marketing scenarios. Their results indicated that only one marketing scenario was able to cover total costs.

Dramm et al. (2004) reviewed the published literature on log sort yards and outlined a methodology for planning and assessing the feasibility of log sort yards. Their recommendations included evaluating gross margins for log products before doing an in-depth financial analysis and utilizing higher value logs to offset marginal or loss-making logs.

Economic feasibility studies determine the practicality of a particular project. As shown by the reviewed literature, they often assess the economical viability of a given processing operation or potential business. According to Newnan and Lavelle (1998), there are three major methods of economic analysis: net present value, annual cash flow, and rate of return. Net present value analysis was used to compare costs and benefits over the project life by discounting them to present values. A positive net present value means that the benefits are greater than the costs and a negative net present value means that the costs are greater than the benefits. A project will have a positive net present value if it is economically feasible. Annual cash flow analysis compares costs and benefits that occur in the same year and can't be used to analyze projects that occur in more than year. Rate of return analysis determines the interest rate that the project will return to the capital required to finance the project. The greater the rate of return, the more desirable the project becomes for investors.

1.5.0 Justification

The utilization of SDT can have numerous environmental, economical and social benefits. Environmental benefits include forest fire mitigation, increased forest stewardship, increased ability to control forest composition, and increased wildlife habitat and forage. By harvesting SDT, overstocked forest stands can be thinned to normal stocking levels, therefore, decreasing the risk of artificially caused wildfires. Figure 10 (Virginia Department of Forestry, 2005a) shows the fire risk map for Virginia.

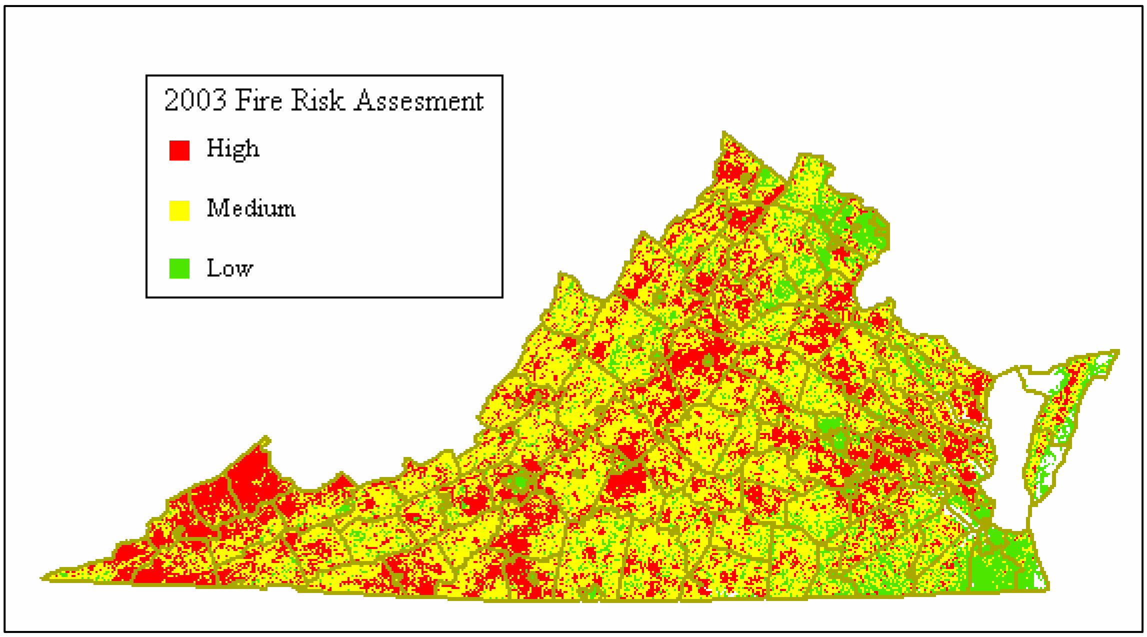

Figure 10. Virginia Fire Risk Assessment Map.

Most of Southwest Virginia has a high to medium fire risk assessment. The risk assessment is based on historic fire occurrence, land use, forest cover type, distance to roads, slope, and other factors (Virginia Department of Forestry, 2005b). Utilization of SDT may reduce the fire risk somewhat, but some forests will always have a higher fire risk due to remoteness and terrain.

Additional markets for SDT would enable forest landowners to actively manage their forests and meet their stewardship goals. An example of this is the thinning of a forest stand to promote the growth and value of the residual trees or the thinning of a forest stand to promote the production of wildlife mast such as acorns from oak trees. The development of engineered wood products has created a market in other regions for low grade and small diameter diffuse-porous hardwoods. Ring porous species such as oak, hickory, ash, and others need viable low grade and small diameter roundwood markets to balance the natural composition of the forest.

Economical and social benefits of SDT utilization would positively affect forest landowners, loggers, primary producers and the community and region as a whole. Forest landowners could receive income from thinning their forests, which would offset the costs of thinning. Increased growth rates in the residual stand would decrease the rotation age for harvesting and therefore make active forest management more economically attractive. In the long run, this scenario could lead to greater financial returns on forestland and therefore decrease the likelihood of converting forestland to other uses such as housing developments. The societal benefits from sustainably managed forests include water quality, air quality, aesthetics, wildlife habitat and recreation.

Additional markets for SDT will enable loggers to sell logs that usually remain in the residual stand, which could increase the total value derived from a given harvesting operation. Primary producers would benefit from SDT utilization in the form of a larger, less expensive raw material supply. New technology such as curve sawing and scanning and optimization equipment may be necessary to economically utilize SDT. This new technology improves yields and value from logs. This increased yield and value could translate into a competitive cost advantage for primary producers. An increase in forest management and primary processing associated with SDT utilization would benefit communities in the form of increased employment opportunities, higher wages than service sector jobs, an increase in the tax base, and an increase of raw material supply for secondary manufacturing.

The ecological, economical, and social benefits, in conjunction with the logical justification, of increasing utilization of SDT and increasing forest management activities are well established in theoretical forestry research. However, in order for rational companies and individuals to undertake such SDT utilization, a profit must be made. Therefore, the question is whether or not it is economical to utilize SDT. As cited previously, SDT is used for pulpwood and engineered wood composites. However, these markets don't cover the cost of harvesting only SDT. So higher value markets such as lumber should be investigated, but can it be made into lumber? Previous research on converting SDT into lumber focused on volume and value yield (Hamner et al. 2002; Cumbo et al. 2004; Wiedenbeck et al. 2004) and didn't assess economic feasibility.

1.6.0 Objectives

Given the justification for utilizing hardwood SDT and the lack of current research into the economic feasibility of utilizing hardwood SDT, the objectives of this research project are:

1. Determine the economic feasibility of a red oak SDT sawmill and pallet part mill located in Southwest Virginia.

2. Determine the volume and value yield of red oak lumber, cants, pallet parts, bark, chips and sawdust from SDT and the market potential for these products.

3. Develop a business model for a red oak SDT sawmill and pallet part mill located in Southwest Virginia.

1.7.0 Resource Analysis

1.7.1 Introduction

A resource analysis is imperative in any resource extraction industry, such as the forest products industry. A stable supply of raw materials is crucial for a forest products business to operate. Therefore, an analysis of the small diameter timber resource within Southwest Virginia was conducted.

1.7.2 Methods

The resource analysis was conducted using the United States Forest Service's Forest Inventory Analysis Mapmaker Version 2.1 (USFS 2001) to estimate stand volumes of SDT by county and species per the 2001 VA inventory. The volume of growing stock in cubic feet was used to estimate the stand volume. The data was filtered for the six, eight, and ten inch diameter groups. Next, the USFS Timber Products Output Mapmaker Version 1.0 (USFS 2002) was used to determine volumes of SDT consumed by species in each county per the 2002 Resource Planning Act assessment. The volume of all removals in cubic feet was used to estimate the consumed volume.

Both stand volume and consumed volume were converted to board feet by multiplying by the board footage to cubic footage ratio, approximately 6.5, established in the subsequent yield study. The available volume of SDT was calculated by multiplying stand volumes by a landowner willingness to manage factor (LWMF) and then subtracting consumed volume as shown in Equation 1. This factor was set to 0.1, 0.2, 0.3, and 0.4 representing 10%, 20%, 30%, and 40% of forest landowners willing to manage and/or harvest their forestland.

$$AV = (SV*LWMF) - CV \qquad \textbf{Equation 1.}$$

where:

AV = available volume

SV = stand volume

LWMF = landowner willingness to manage factor

CV = consumed volume

Birch et al. (1998) found that 44% of forestland owners never intended to harvest timber. However, the authors discovered a relationship between the acreage owned and harvest intentions. Owners of larger tracts, greater than 10 acres, were more willing to harvest timber, with 53% indicating plans to harvest within 10 years. This research suggests that the reduction factors used in the resource analysis are prudent.

Due to differences between TPO data and FIA data, some aggregations of data were made. The other hardwood species group includes buckeye, birch, catalpa, persimmon, butternut, magnolia, paulownia, sycamore, black cherry, black locust, elm and other species. The other eastern softwoods species group includes eastern redcedar, virginia pine, spruce and balsam fir, and other species (Alerich et al. 2004).

1.7.2 Results

The most abundant species of SDT available in Southwest Virginia is the other White oak group, followed closely by the "other" hardwood group and Yellow poplar as shown in Figure 11. Four of the species groups are ring porous hardwoods whereas the remaining five groups are diffuse-porous. The available volume of the remaining ten species is shown in Figure 12.

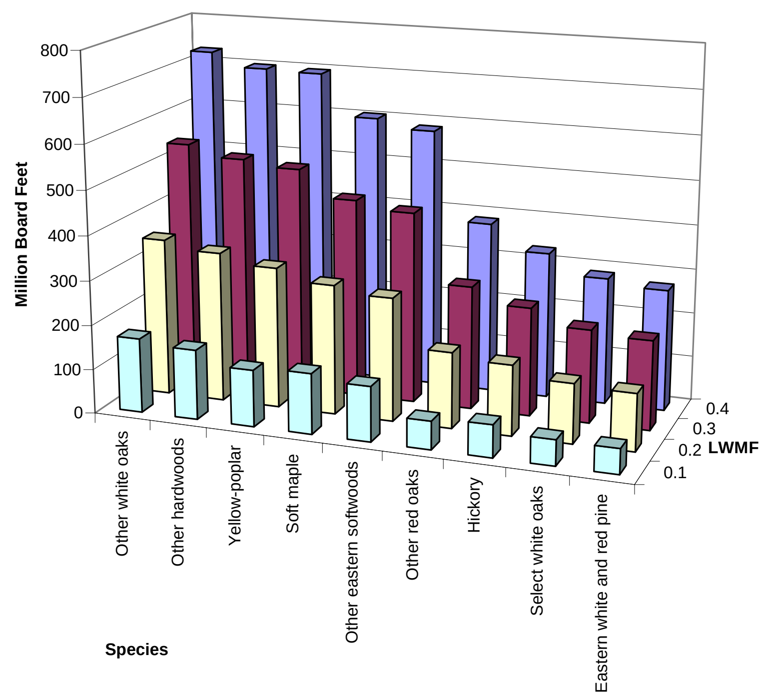

Figure 11. Available Volume of SDT by Species I.

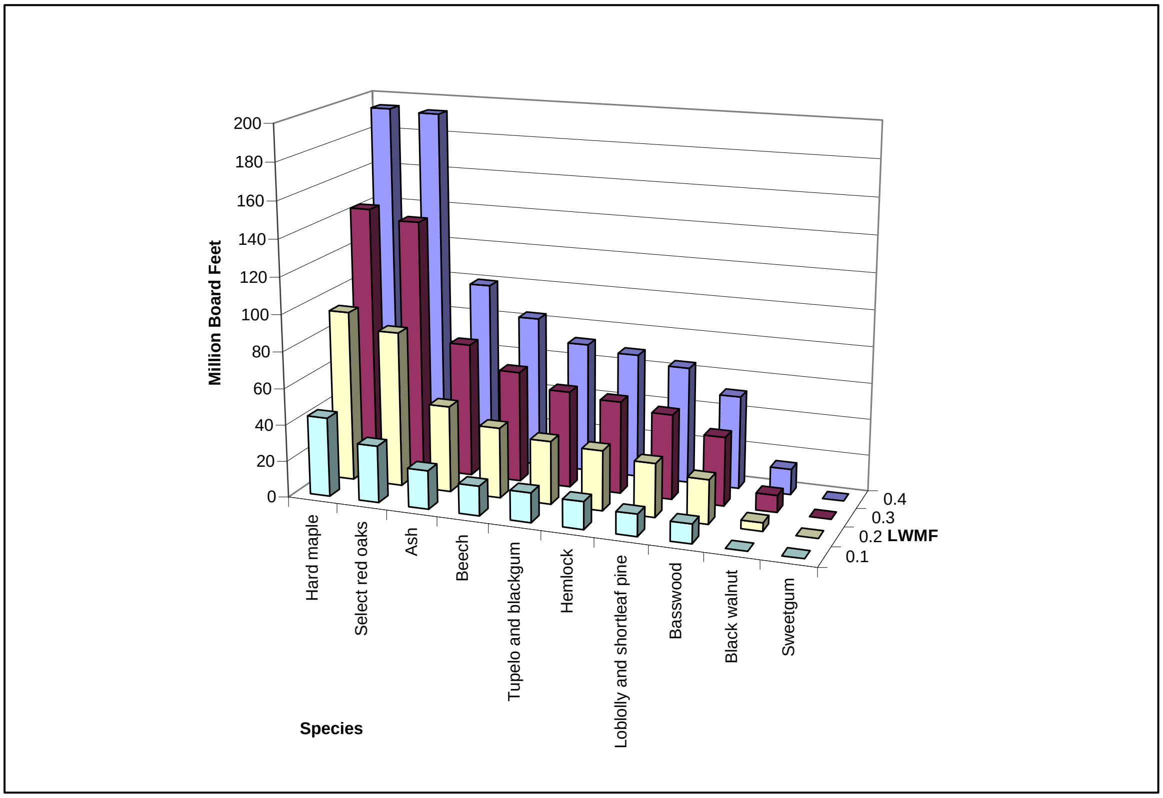

Figure 12. Available Volume of SDT by Species II.

As discussed earlier, engineered wood products have created markets for diffuse-porous SDT. The subsequent yield study conducted as part of this research utilized red oak as the selected log species. Therefore the red oak group, including other red oaks and select red oaks, volume was quantified by county as shown in Figure 13 and Figure 14. Most of the red oak SDT volume in Southwest Virginia is in Craig, Bland, Pulaski, Smyth, and Tazewell counties.

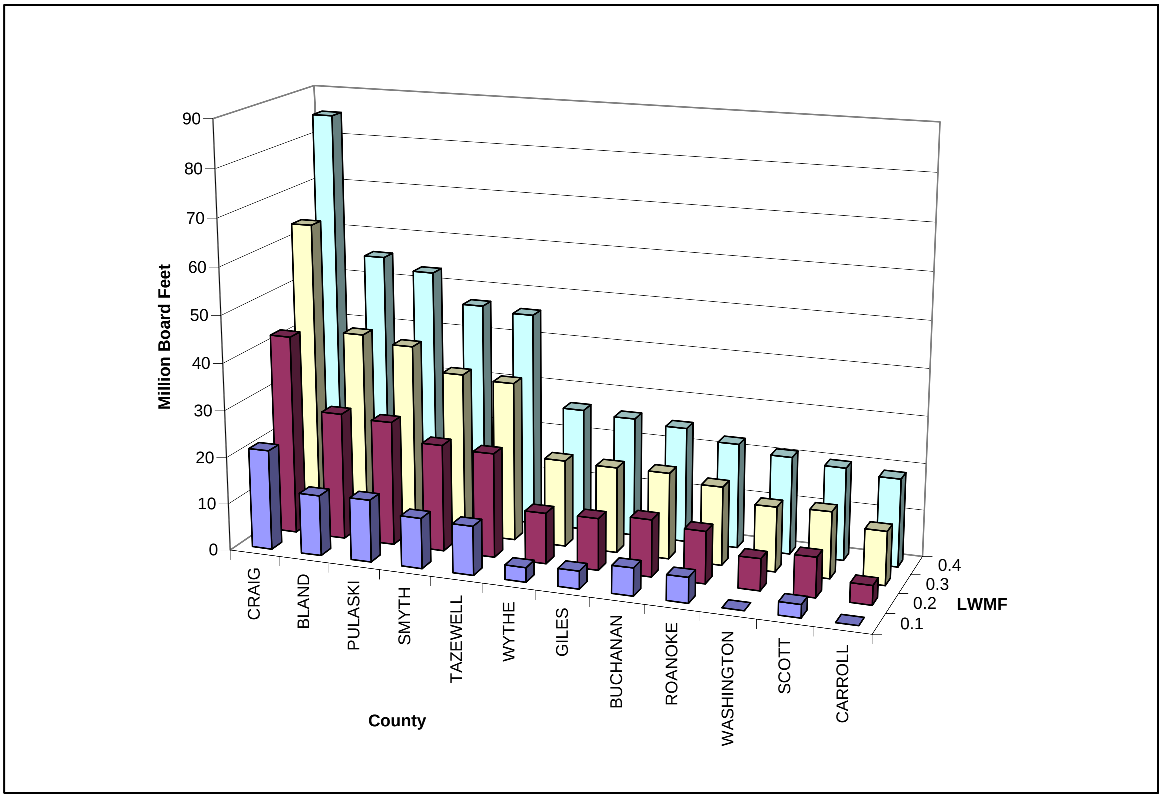

Figure 13. Available Volume of Red Oak SDT by County I.

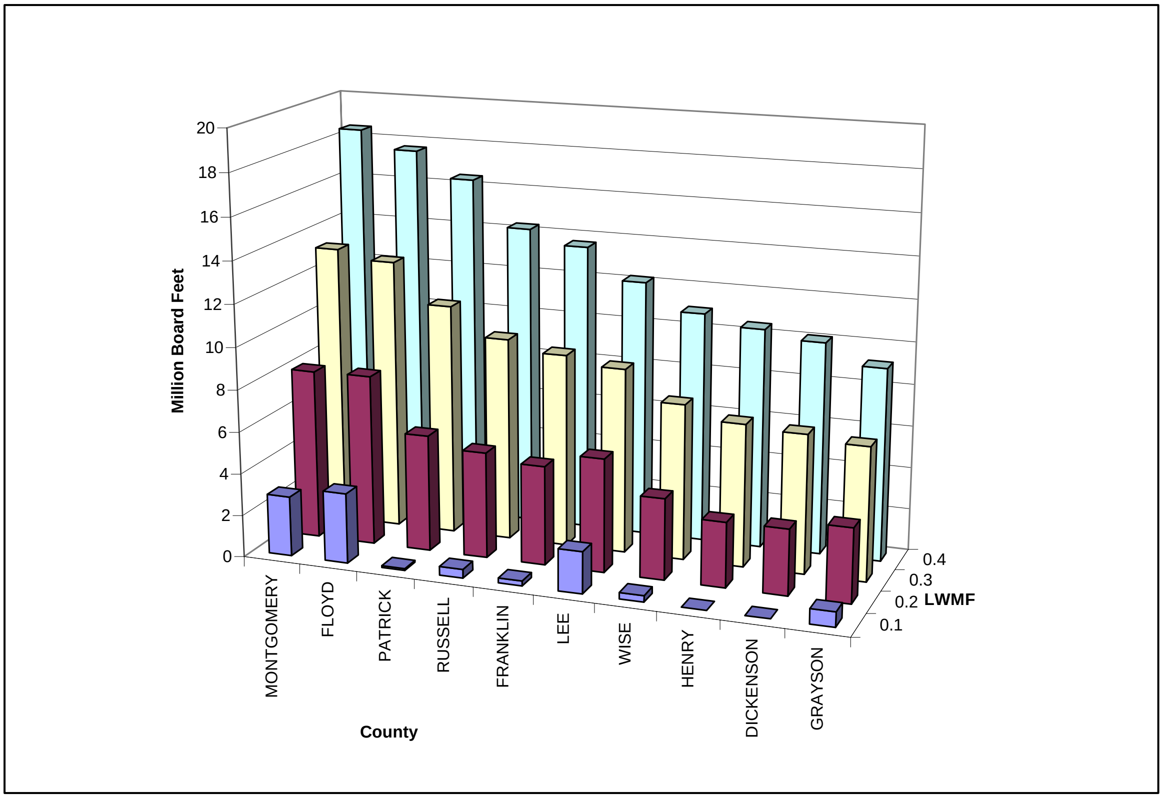

Figure 14. Available Volume of Red Oak by County II.

The total Red oak SDT volume for Southwest Virginia is shown in Figure 15. As shown in the figure, the National Forest owns the majority of the total Red oak SDT volume in Craig, Bland, Wythe, and Giles counties. The location of SDT volumes will be important in the business planning portion of this research.

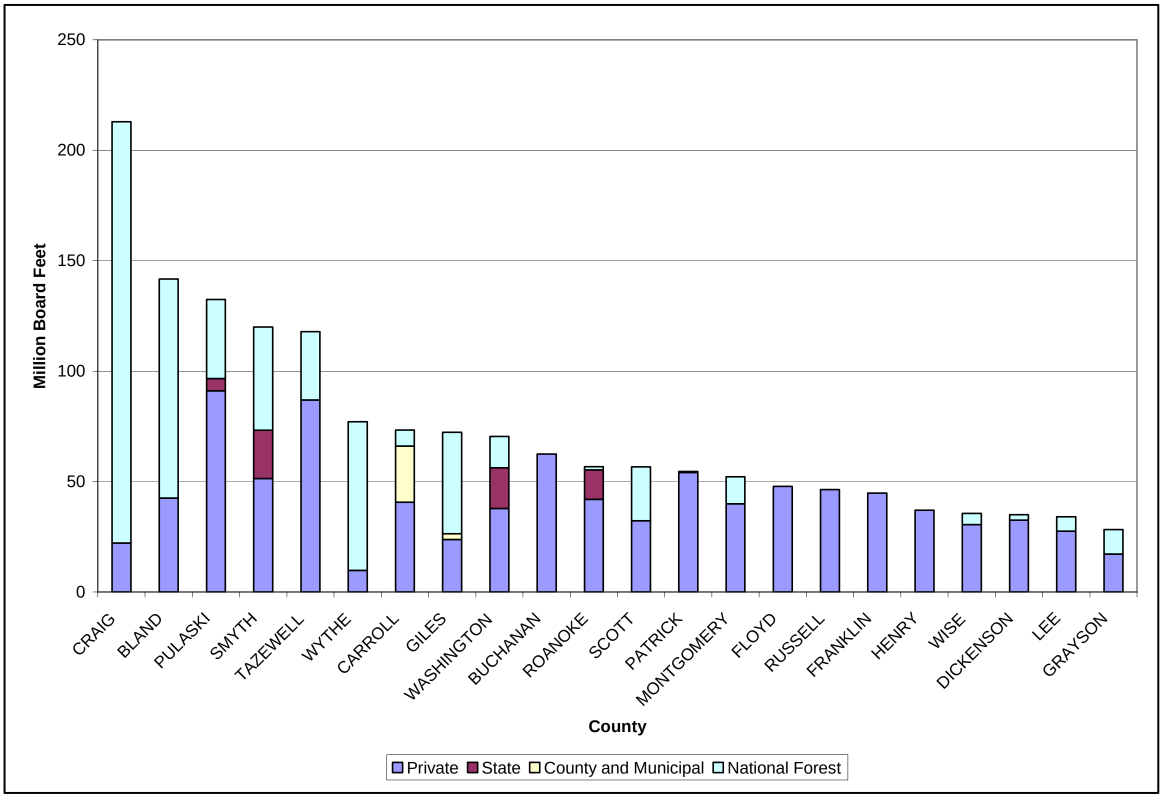

Figure 15. Total Red Oak SDT Volume by Owner and County

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2.0 Yield Analysis

2.1.0 Introduction

Research to identify lumber yield from hardwood small diameter timber (SDT) (Hanks et al. 1980; Cumbo et al. 2004) discovered high proportions of lower grade lumber and these grades are most often used in pallet and flooring manufacturing. Craft and Emanuel (1981) and Serrano and Cassens (2000) investigated the yield of pallet cants and pallet parts from SDT. Cants, pallet parts and lumber were produced to investigate the yield of lumber and pallet parts from SDT. A yield study was initiated at a local hardwood scragg mill which is operated in unison with a pallet part manufacturing operation. This particular scragg mill had a shifting twin circular saw and rotating end dogging setup, gang re-saw, edger, and trimmer. The pallet part operation consisted of a cut-off-saw, gang re-saw, part salvager, and a double head notcher. The scragg mill was chosen because its design allows processing of logs into cants and lumber at high feed rates, and has low investment and operating costs (McCay and Wisdom 1984).

Red oak was chosen for the yield study because of its relative abundance in Southwest Virginia; the lack of engineered wood product markets for ring porous species; and its being a common species for the flooring and pallet market, which Cumbo et al. (2004) suggested as a likely market for lumber derived from SDT.

After discussions with mill personnel at the case study mill, the minimum acceptable diameter was set at six inches due to limitations of the log processing equipment. Given this restriction, the small end diameter range was limited to between six and ten inches.

2.2.0 Methods

The red oak logs used in the study were sampled from the participating mill's log inventory. The target sample size was 50 red oak logs for each one inch small end diameter class from six to ten inches, for a total of 250 logs. The small end diameter was measured along two axis (perpendicular to each other) and averaged and the length of the logs was also measured. The range for each diameter group was from 0.4 below the nominal diameter to 0.5 above the nominal diameter. For example, the diameter range for the six inch group was from 5.6" to 6.5". Each group of logs was marked with a unique color on the end of log in order to facilitate sorting and tracking. The logs were not graded due to diameter limitations of the U.S. Forest Services' *Standard Grades for Hardwood Factory Lumber Logs* (Vaughan et al 1966; Rast et al. 1979) and log quality had no impact on whether a log was included in the study or not. The participating scragg mill produces lumber from relatively lower quality, smaller logs as compared to a grade sawmill. The case study mill's minimum small end diameter is 8". The logs in the 6" and 7" diameter groups were sampled from a log pile that had been sorted for species out of their pulpwood inventory. A summary of the logs used in the yield study is shown in Table 1.

Table 1. Log Sampling Summary

Log Group	6"	7"	8"	9"	10"	**Total or Average**
Number of Logs	33	50	50	50	50	**233**
Average Diameter (in.)	6.2	7.2	8.1	9.0	9.9	**8.1**
Average Length (ft)	12.5	11.6	11.2	11.3	11.4	**11.6**
Log Scale (Int. 1/4)	496	995	1272	1653	2103	**6518**
Volume (ft^3)	87	164	200	248	304	**1002**

There were only 33 logs in the six inch diameter group due to log availability and time considerations. The participating mill stored the logs until the scheduled day of the yield study. Figure 16 is a photo of some of the logs used in the study. Six inch logs are painted green; seven inch logs are red; eight inch logs are blue; nine inch logs are yellow; and ten inch logs are orange.

Figure 16. Yield Study Logs

The participating mill sorted the logs into the respective diameter groups; emptied chip bins; removed bark from around the debarker; and supplied a dump truck to facilitate the weighing of chips and sawdust. Each group of logs was milled separately but sequentially through the sawmill.

First, the logs were de-barked by a Rosser-head type debarker. The logs were sawn at the scragg headrig which produced a two-sided cant, slabs and sawdust. The slabs were chipped. The weight of chips and sawdust produced from each log group was determined by scales on site. It was not possible to weigh the bark and therefore, the bark pile volume was measured and then converted to a weight. The total bark weight was estimated by multiplying the volume by green bulk density (25.8 lb/ft^3) of hardwood sawdust and bark (Harris and Phillips 1989).

The weight of bark for each log group was calculated using weighted ratios. The weight of bark was allocated to each log group as a ratio of each log group's volume to total log volume. For example, the log volume for each log group was calculated by summing the volume of individual logs in that group. The total log volume of all five log groups was calculated by summing the volumes for all groups. The ratio was calculated as shown in Equation 2.

$$Ratio_i = V_i / V_T$$ **Equation 2.**

where:

V_i = volume for i^{th} group

i = the i^{th} diameter group

V_T = total log volume of all groups

This ratio was calculated for each log group. Each group's ratio was then multiplied by the total weight of bark to determine the weight of bark for each log group as shown in Equation 3.

$W_i = Ratio_i * W_T$ **Equation 3.**

where :

W_i = bark weight for the i^{th} group

$Ratio_i$ = ratio for the i^{th} group

i = the i^{th} diameter group

W_T = total bark weight

After initial breakdown at the scragg headrig, the two-sided cants were processed through a gang re-saw which produced a three inch thick cant and 1-inch thick lumber. The cant volume was measured and it was sent to the pallet part operation where it was cut to length and processed into pallet parts through a gang re-saw. The lumber was edged, end trimmed, tallied and graded according to the mill's grading rules. The pallet parts were measured and then counted. Cull pallet parts were counted but not included in the volume yield. This process was repeated for each log group. Approximately 700 board feet of 2A &3A lumber, from all five log groups, was marked according to its log group and set aside for use in a subsequent flooring yield study.

Data were summarized by log group and in aggregate. Overrun/underrun were calculated using cant and lumber volumes. Lumber and pallet part yield were calculated with nominal thickness, 1" and 7/16", respectively.

2.3.0 Results

The lumber, pallet part and residue weight yield for all log groups was 35% solid wood, 29% chips, 26% sawdust and 10% bark as shown in Figure 17. Lumber and pallet parts totaled 14.0 tons, chips 11.7 tons, sawdust 10.3 tons, and bark 4.2 tons. The lumber and pallet parts were not weighed but their weight was estimated using the average green moisture content (75%) and weight per thousand board feet (5,102 lbs) from the *Dry Kiln Operator's Manuel* (Simpson 1991).

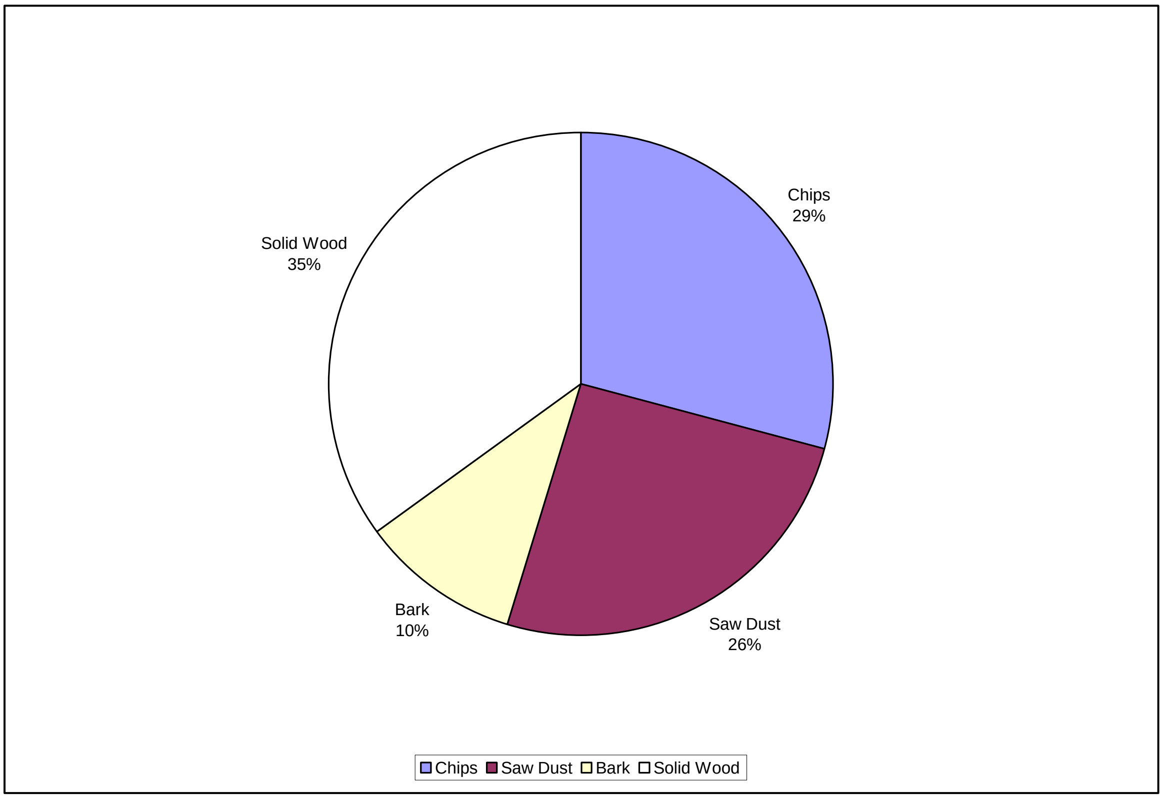

Figure 17. Total Solid Wood & Residue Yield

The residue yield per thousand board foot of lumber produced decreased with increasing log diameter as shown in Figure 18.

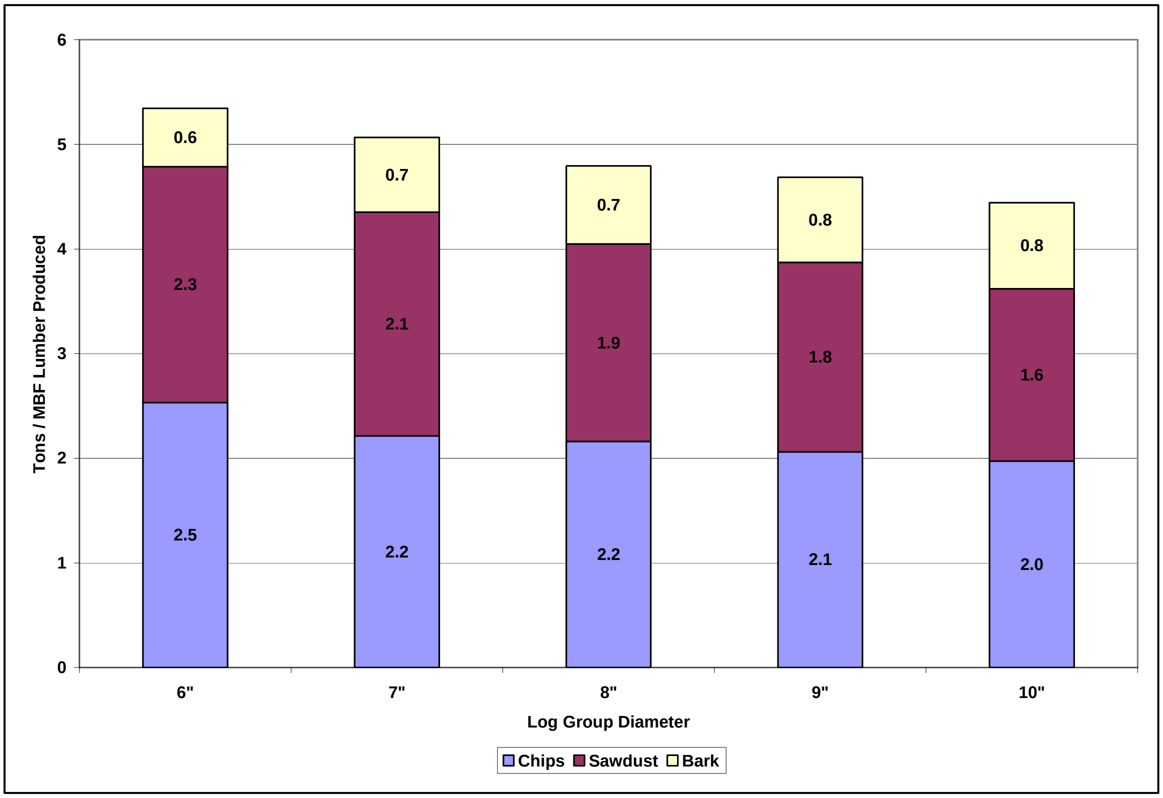

Figure 18. Residue Yield by Log Group

The proportional volume of cants decreased as log diameter increased. In the six and seven inch log groups, cants accounted for over 70 percent of total log group volume; whereas in the ten inch group cants account for only 54 percent of total log group volume. The yield of cants and lumber is shown in Figure 19.

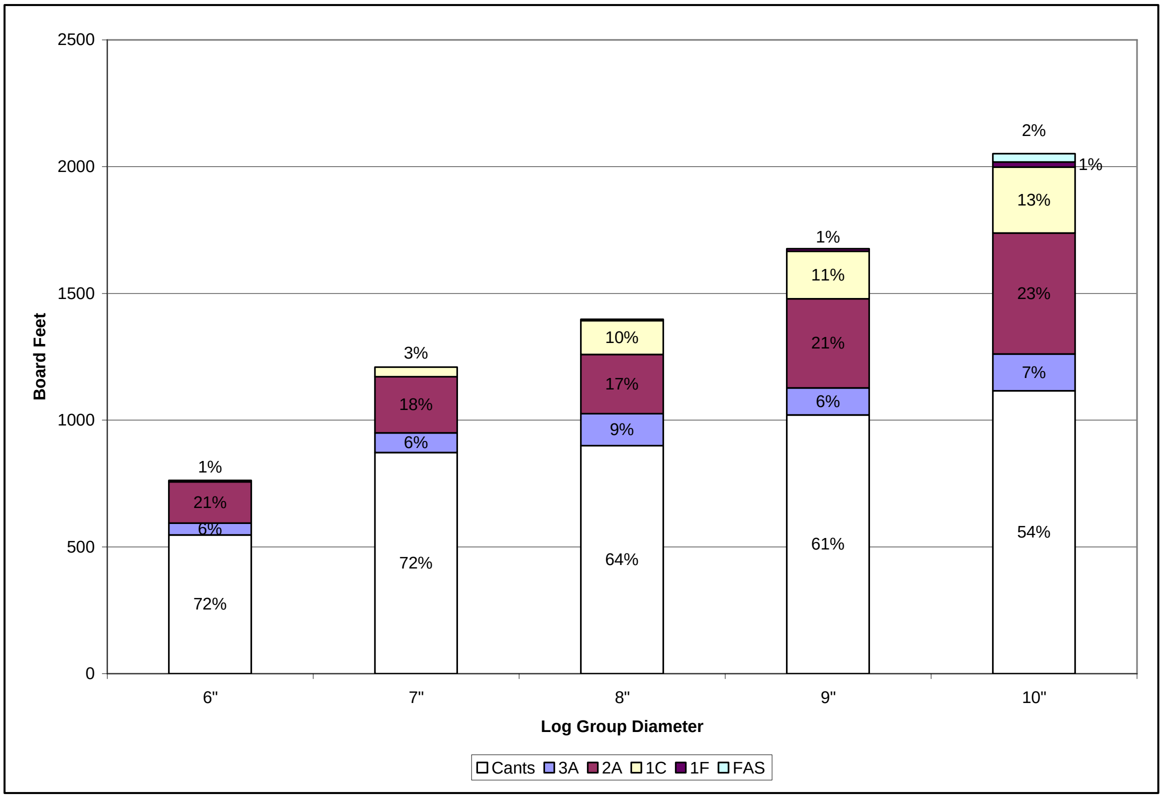

Figure 19. Cant and Lumber Yield

The yield of pallet parts from cants ranges from 63% to 66% as shown in Figure 20. No discernable trend is evident in the data vis-à-vis pallet part yield and log group diameter.

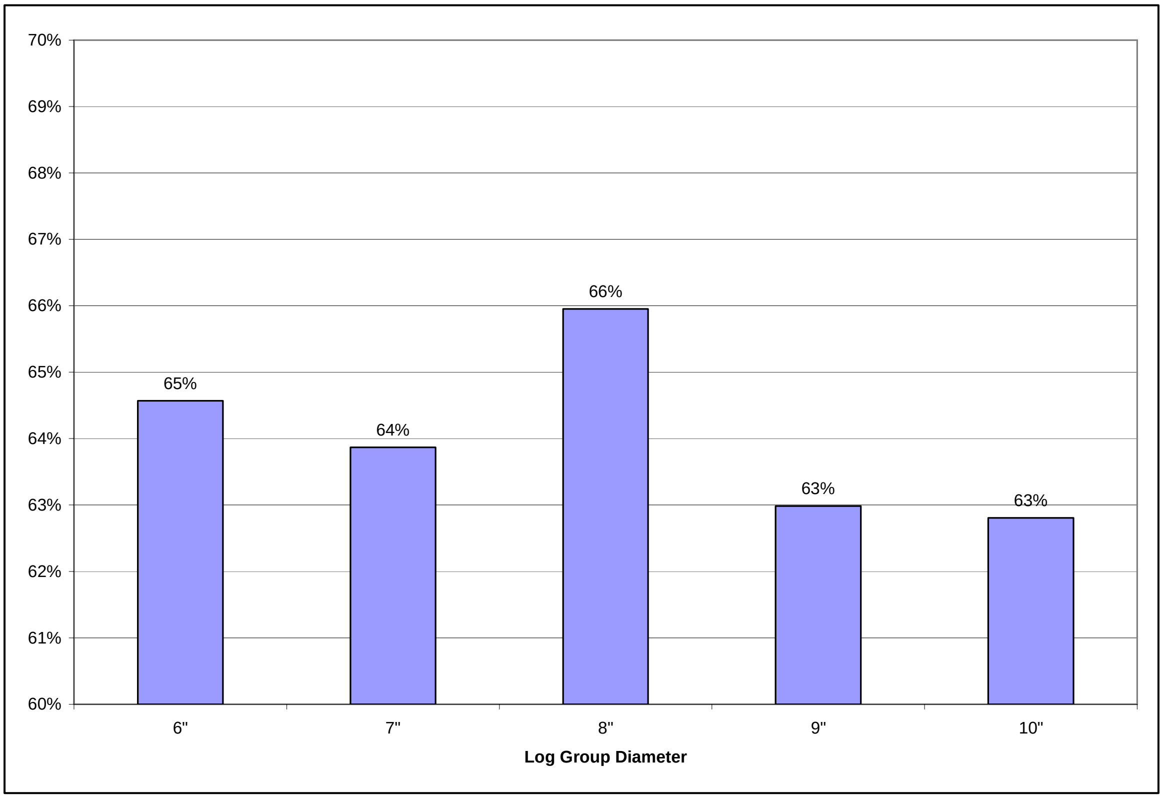

Figure 20. Pallet Part Yield

The pallet part size yield is shown in Figure 21. The majority of the pallet parts were 70 inches long. Cull pallet parts accounted for 6% to 11% of the total volume depending upon log group.

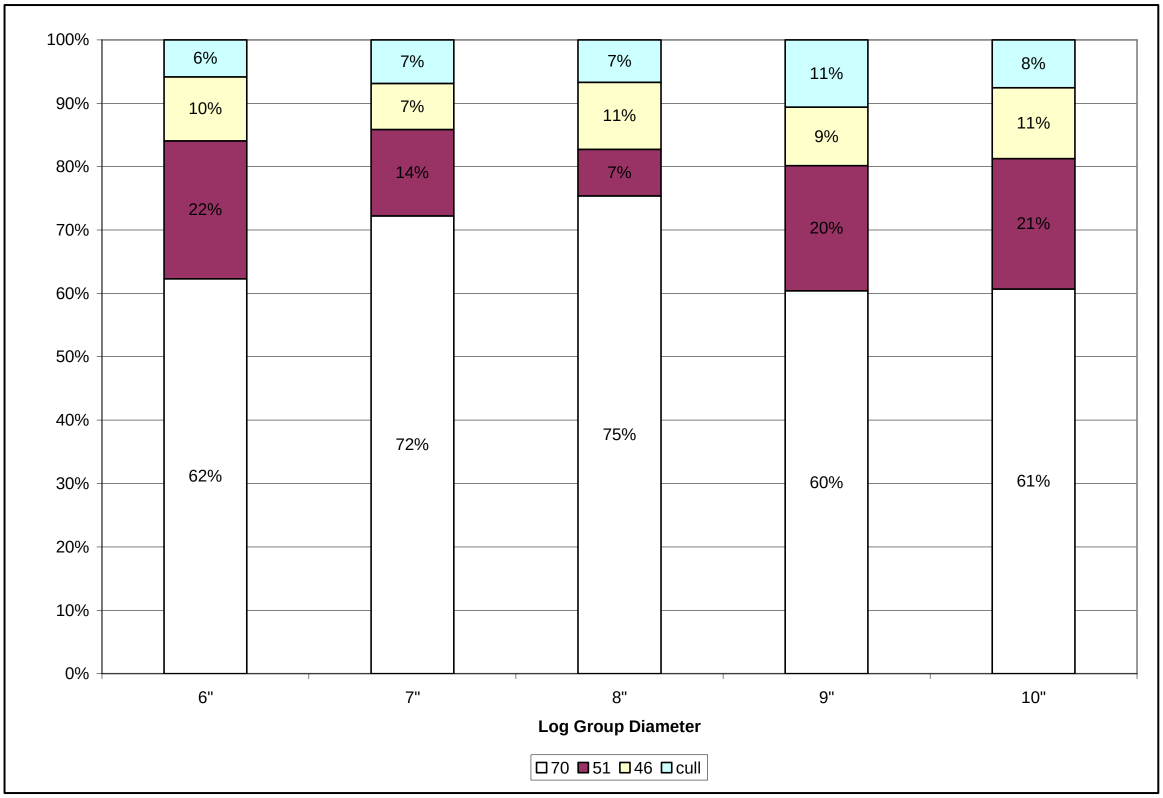

Figure 21. Pallet Part Size Yield

The proportional volume of number one common (1C) lumber increased as log group diameter increased, with the eight inch and larger groups having over one quarter of their total lumber volume yield 1C lumber as shown in Figure 22.

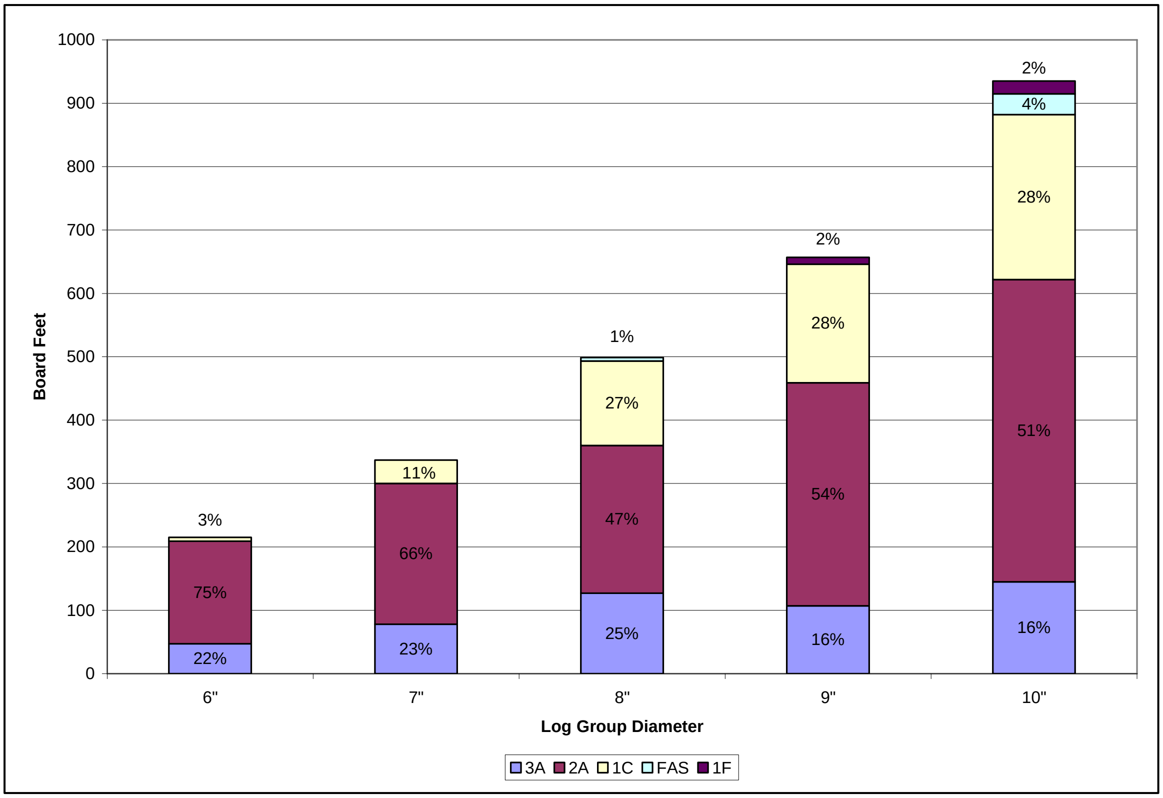

Figure 22. Lumber Grade Yield by Log Group

The lumber yield was primarily low grade, with 3A and 2A accounting for nearly 75% of the total lumber volume. The remaining volume was mostly 1C grade lumber as shown in Figure 23.

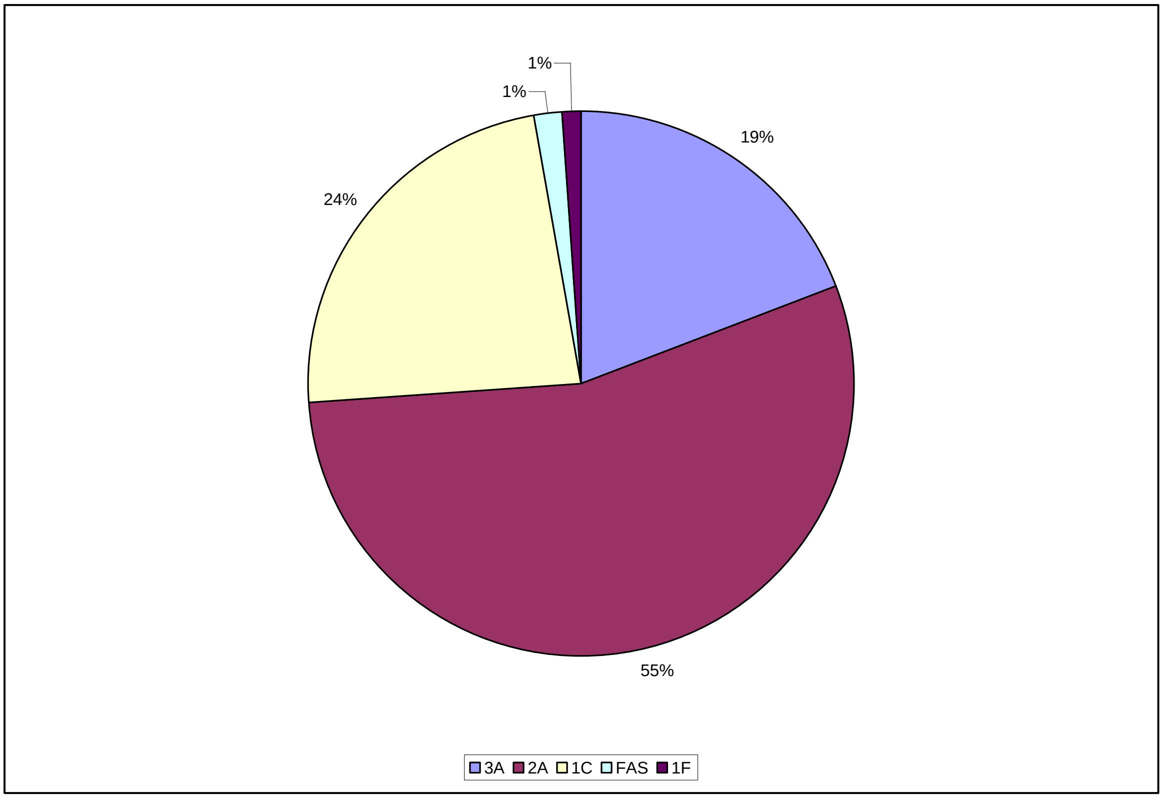

Figure 23. Total Lumber Grade Yield

The over run and under run based on the cant and lumber volume for each log group in the yield study is shown in Figure 24. Overrun decreased as log diameter increased.

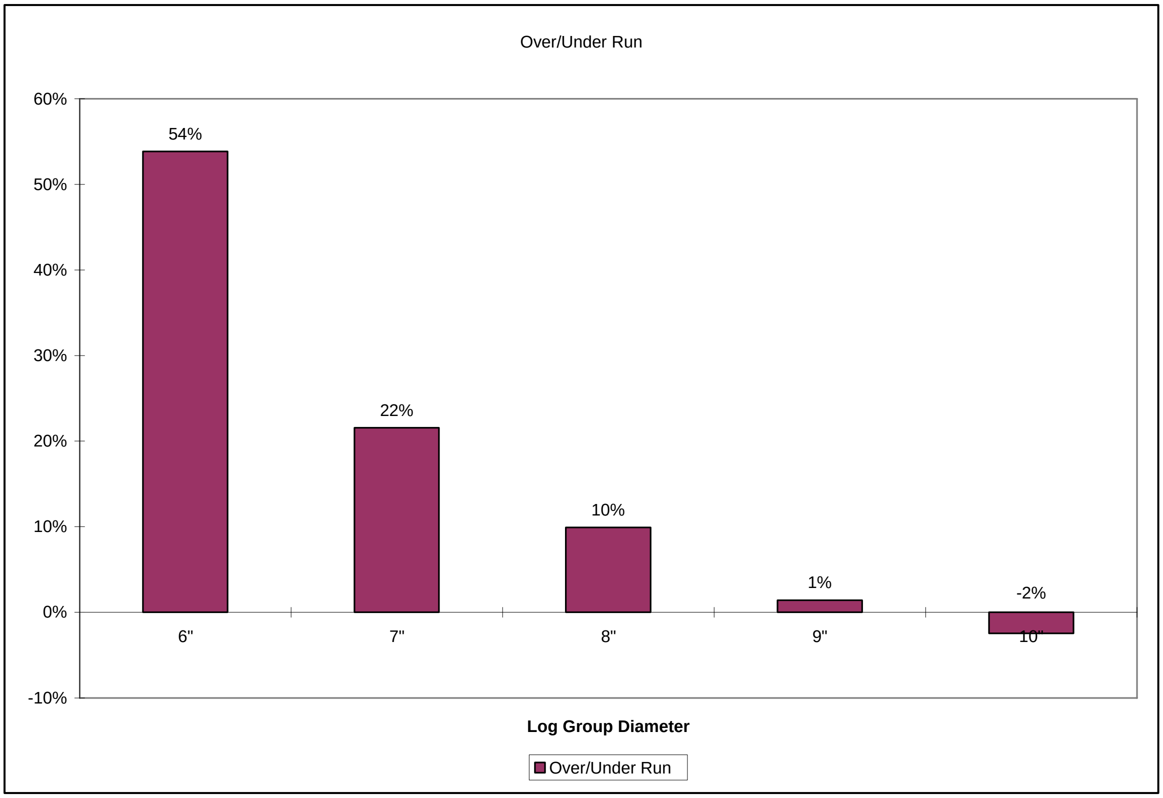

Figure 24. Over Run by Log Diameter

2.4.0 Discussion

The overall residue yield (excluding solid wood) of 45% chips, 39% sawdust and 16% bark was comparable to yields discovered in other studies (Page and Baxter 1974 *In* Koch 1985; Massengale 1971 *In* Koch 1985). The amount of total residue per board foot of lumber produced was inversely proportional to log diameter. The residue yield range of 5.4 tons/MBF for the six inch group and 4.4 tons/MBF for the ten inch group was similar to those reported by Page and Baxter (1974) and Massengale (1971) as shown in Figure 25.

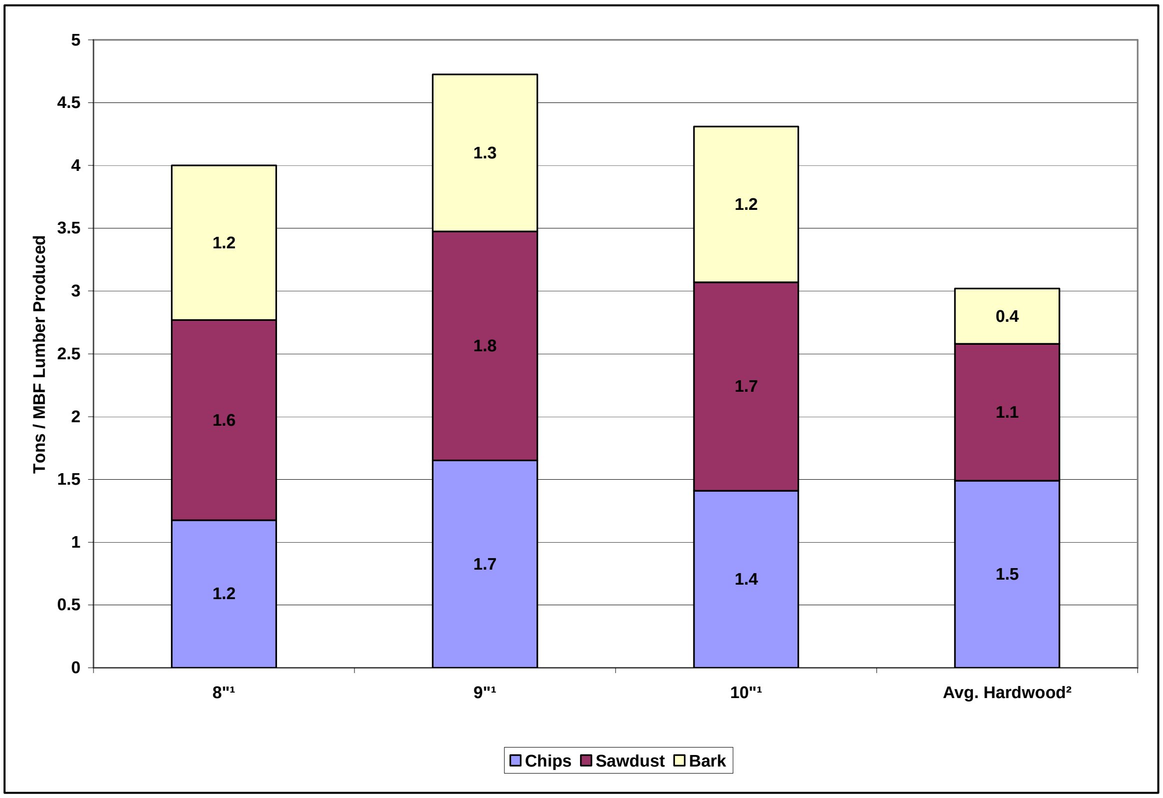

Figure 25. Empirical Residue Yields Adapted from [1]Massengale, 1971 & [2]Page and Baxter, 1974

The decrease in cant volume, from 72% in the six inch group to 54% in the ten inch group, as diameter increased is evident in other yield studies (Craft and Emanuel 1981; Holt *In* Denig 1993). The cant thickness remained the same, 3" in this study, but the cant width increased and the amount of 1-inch thick lumber increased as the diameter increased. The 1-inch thick lumber that was produced was low grade, with 2A and 3A accounting for 55% and 19%, respectively. Number one common lumber accounted for 24% of the total lumber produced and the eight inch and larger groups contained up to 13% of this grade.

Pallet part yield ranged from 63% to 66% and there was no obvious relation to log diameter. This yield is below cant grade two, 77% yield, but above cant grade three, 47% yield, according to the grading scheme suggested by Mitchell et al. (2005). The pallet part yield achieved in this study was in accordance with the weight yield, 64%, found by Serrano and Cassens (2000). These results, when compared with the previous research, suggest that these pallet part yields should be attainable by pallet part mills on a continuous basis.

The overrun for the six and seven inch log groups was 54% and 22%, respectively. The overrun can't be compared to other studies (Hanks et al. 1980; Holt *In* Denig 1993) because they lack these diameter groups. Both of these cited studies graded logs according to the USDA Forest Services' *Standard Grades for Hardwood Factory Lumber Logs* (Vaughan et al. 1966; Rast et al. 1979). This multiple grade (F1, F2, & F3) system excludes logs less than eight inches scaling diameter. This exclusion limits the ability of researchers to compare the relative quality and yield of small diameter logs.

2.5.0 Summary

The total solid wood and residue yield included lumber and pallet parts (35%) chips (29%), sawdust (26%), and bark (10%). The majority of solid wood produced was in the form of 3" thick cants, whose proportional volume decreased with increasing log diameter. Seventy-four percent of the total lumber produced was 2A and 3A and twenty four percent was 1 common. The yield of pallet parts ranged from 63 percent to 66 percent. Future yield studies should measure taper and large end diameter of logs to achieve greater accuracy in estimations of cubic foot volume. Future yield studies should weigh logs and lumber so that the yield of residues and solid wood products can be directly compared. Furthermore, the anticipated utilization of small diameter logs will limit the efficiency of volumetric log scaling, whether based on cubic or board foot rules.

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3.0 Economic Feasibility Analysis

3.1.0 Introduction

Economic feasibility studies determine the practicality of a particular project. As shown by the reviewed literature, they often assess the economical viability of a given processing operation or potential business. McCay and Wisdom (1984) determined the economic feasibility of nine different sawmills that could utilize SDT from Southwest Virginia. Their results showed that only two mills, a short log mill and a scragg mill, were economically feasible at an 80% operating capacity. Lin et al. (1995) used net present value (NPV) and internal rate of return (IRR) analysis to establish the economic feasibility of producing red oak dimension parts directly from grade 2 and grade 3 logs. They concluded that it was economically feasible and that their theoretical plant had higher profitability than sawmills. The economic feasibility of producing lumber, cants, pallet parts and residues from hardwood small diameter timber (SDT) has not been investigated. Therefore, an economic feasibility analysis was initiated.

According to Newnan and Lavelle (1998), there are three major methods of economic feasibility analysis: net present value, annual cash flow, and rate of return. These methods have not been used extensively in the sawmill and pallet segments of the forest products industry (Bush and Sinclair, 1987).

The economic feasibility analyses used in this research included: break even analysis, net present value, and internal rate of return analysis. These analyses were used to determine the economic viability of a sawmill & pallet part mill that would utilize red oak small diameter timber (SDT). The sawmill was a scragg mill that had a shifting twin circular saw and rotating end dogging setup, gang re-saw, edger, and trimmer. The pallet part operation consisted of a cut-off-saw, gang re-saw, part salvager, and a double head notcher. Break even analysis was used to determine which log diameters (6”-10” small end diameter) would be profitable if only that diameter group was utilized by a hypothetical sawmill and pallet part mill under different yield, cost, and processing conditions. Net present value and internal rate of return analysis were used to determine the economic feasibility assuming equal utilization of all log diameters under variable cost and processing conditions.

The analysis of multiple scenarios enabled the determination of approximate maximum delivered log cost and the effect of yield variation and processing level on economic feasbility. Assumptions required for the economic analysis such as: discount rate, project life, initial investment, land cost, and working capital required were justified.

3.2.0 Methods

3.2.1 Overview

The determination of economic feasibility requires the estimation of annual revenues, annual costs and net incomes over the life of the processing facility. The yield of sawdust, bark, chips, lumber, cants, and pallet parts, which was determined in the yield analysis part of this research, was utilized in conjunction with the participating mill’s capacity, and current market prices to generate annual revenues. The variable costs along with fixed costs were attained from the participating mill and were used to generate annual costs. These revenues and costs were used in the break even analysis to determine which log diameter groups would be profitable if a hypothetical mill of the same design produced products using only that log diameter group. Revenues and costs based on an equal volume from each profitable log diameter group were used to calculate net income which in turn was used for the determination of net present value and internal rate of return.

In a typical business analysis, break even analysis is used to determine the volume at which sales are equal to costs (Ingram et al., 1999). The break even analysis in this study compared the ratio of annual revenues to annual costs (revenues/costs) for each log diameter group under a number of different scenarios in order to determine which log diameter groups would be profitable. The log groups that would be profitable under rational scenarios were then pooled and the revenues, costs, and net incomes were used in the net present value and internal rate of return analyses.

Net present value analysis compares costs and revenues over the project life by discounting them to present values. A positive net present value means that the revenues over the project life are greater than the costs incurred during the project; and a negative net present value means that the costs are greater than the revenues. An economically feasible project will have a positive net present value (Newnan and Lavelle, 1998). Rate of return analysis determines the rate that the project will return to the capital required to finance the project. The greater the rate of return, the more desirable the project becomes for investors.

A description of the methods and assumptions used to estimate revenues, costs, and net incomes is contained in following section. The methods and assumptions of break even analysis and the net present value and internal rate of return analyses are also described in their respective sections.

3.2.2 Revenue Calculation

Annual revenues were calculated for the break-even, net present value, and internal rate of return analyses. The yield of sawdust, bark, chips, lumber, cants, and pallet parts was utilized in conjunction with mill capacity and current market prices (Table 2) to generate annual revenues.

Table 2. Current Market Prices.

Product	HMR[1] ($/MBF)	HRX[2] ($/MBF)	Avg.
FAS	$1,110	$1,060	$1,085
FIF	$1,100	$1,060	$1,080
1C	$625	$600	$613
2A	$500	$510	$505
3A	$425	$435	$430
Cants	$320	$305	$313
Pallet parts ($ average/piece)			$0.36
Chips ($/delivered green ton)			$22
Sawdust ($/delivered green ton)			$10
Bark ($/delivered green ton)			$14

[1] Hardwood Market Report. July 1, 2006. [2] Hardwood Review Express. July 7, 2006

Table 3. Product Yield by Log Diameter Group

Product	6"	7"	8"	9"	10"
Lumber	Board Feet				
3A	47	78	127	107	145
2A	162	222	233	352	477
1C	6	37	133	187	260
FAS	0	0	6	0	33
F1F	0	0	0	11	20
Cants	547	872	899	1,020	1,116
Residues	Tons				
Chips	1.440	1.980	2.360	2.680	3.230
Sawdust	1.280	1.910	2.060	2.350	2.690
Bark	0.318	0.638	0.816	1.060	1.348
Pallet Parts	No. of Parts				
7/16" x 70"	407	725	799	752	803
7/16" x 51"	142	137	78	246	272
7/16" X 46"	66	73	112	115	148

The product yields for each log diameter group are shown in Table 3. The product yields, except for pallet part yield, were divided by each group's actual log volume resulting in yield-to-log volume ratios. The pallet part yield was divided by each group's actual cant volume resulting in yield-to-cant volume ratios. These yield ratios are shown in Table 4.

The yield ratios (Table 4) for each product (i.e.: lumber, cants, residues, and pallet parts) were then multiplied by the required annual log volume and required annual cant volume in the case of pallet parts, to get annual product volume.

Table 4. Yield Ratios

	Log Group				
Product	6"	7"	8"	9"	10"
3A	0.0949	0.0784	0.0998	0.0647	0.0690
2A	0.3269	0.2232	0.1832	0.2129	0.2269
1C	0.0121	0.0372	0.1046	0.1131	0.1237
FAS	0.0000	0.0000	0.0047	0.0000	0.0157
1Face	0.0000	0.0000	0.0000	0.0067	0.0095
Cants	1.1044	0.8767	0.7069	0.6169	0.5307
Chips	5.8122	3.9819	3.7108	3.2420	3.0725
Sawdust	5.1664	3.8411	3.2391	2.8428	2.5589
Bark	1.2825	1.2825	1.2825	1.2825	1.2825
7/16" x 70"	0.744	0.832	0.889	0.737	0.720
7/16" x 51"	0.259	0.157	0.087	0.241	0.244
7/16" X 46"	0.121	0.084	0.125	0.113	0.133

The actual yield analysis log volume, actual yield analysis cant volume, required annual log volumes, and required annual cant volumes are shown in Table 5.

Table 5. Log & Cant Volumes

Log Group	Actual Log Volume[1] (BF)	Actual Cant Volume[1] (BF)	Annual Log Volume[2] (BF)	Annual Cant Volume[2] (BF)	Annual Log Volume[3] (BF)	Annual Cant Volume[3] (BF)
6"	496	547	6,500,580	12,389,836	1,300,116	2,477,967
7"	995	872	8,226,657	12,525,692	1,645,331	2,505,138
8"	1,272	899	9,097,598	12,129,955	1,819,520	2,425,991
9"	1,653	1,020	9,859,343	12,701,613	1,971,869	2,540,323
10"	2,103	1,116	10,251,743	12,737,930	2,050,349	2,547,586

[1] Total volume from yield analysis
[2] Total volume required for all x" (i.e.: 6, 7, 8, 9, or 10) group production used in break even analysis
[3] Total volume required for equal group production used in NPV & IRR analysis

The required annual log volume was calculated for use in the break even analysis by dividing annual sawmill capacity, 10 million board feet, by the cant and lumber yield (overrun) for each log group. The required annual cant volume for use in the break even analysis was calculated by dividing annual pallet part mill capacity, 8 million board feet, by the pallet part yield for each log group. For example, the required annual log volume for the six inch group is 10 million divided by 1.54 (54% overrun for 6” group) which equals approximately 6.5 million board feet.

Since the NPV & IRR analysis assumed an equal volume from each log diameter group, the required annual log volume was calculated by dividing annual sawmill capacity by 5 for the five logs groups. The quotient was then divided by the overrun for each log group as stated previously. The required annual cant volume for use in the NPV and IRR analyses was calculated by dividing the annual pallet part mill capacity by 5, for the five log groups. The quotient was then divided by the pallet part yield for each log group. The individual group volumes were then summed to get total annual volume (Table 5). These annual log and cant volumes were then used to generate annual product volume by multiplying them by the yield ratios.

The annual product volume was then multiplied by current market prices (Table 2) resulting in annual product revenue. The summation of revenues for all products resulted in annual revenues for that log group. The calculation of annual revenues is shown in Equation 4 .

$$AR_j = \sum_{i=1}^{n} [(PY_{ij} / LV_j) * AV * MP_i] \qquad \textbf{Equation 4.}$$

where:

AR	=	annual revenue
PY	=	product yield
LV	=	log volume
AV	=	annual log volume
MP	=	market price
i	=	i^{th} product (i.e.: lumber grades, residues)
n	=	number of products
j	=	j^{th} log group (i.e.: 6" -10")

The annual revenues from each log group were then used in the break even analysis to compare the profitability of individual log groups. The annual revenues were also used to determine net incomes for use in the NPV and IRR analysis (equal groups). The annual revenues for different scenarios are shown in Table 6.

Table 6. Annual Revenues by Log Group & Scenario

Scenarios		Log Group				
Processing Level	Group Production	6"	7"	8"	9"	10"
Sawmill Only	Individual	$4,272,078	$4,238,335	$4,471,441	$4,569,220	$4,804,957
Sawmill & Pallet Part Mill	Individual	$6,991,241	$6,919,565	$7,379,456	$7,627,938	$8,065,811
Sawmill Only	Equal	$854,416	$847,667	$894,288	$913,844	$960,991
Sawmill & Pallet Part Mill	Equal	$1,398,248	$1,383,913	$1,475,891	$1,525,588	$1,613,162

3.2.3 Cost Calculation

The participating mill provided actual cost information based on their operations. Since this particular mill produces lumber from other species besides red oak; and the mill is also equipped with an additional primary breakdown (circular saw headrig) in addition to the scragg mill, their annual production is well over double the capacity modeled for this research. Therefore, adjustments were made to costs based on ten million board foot capacity (annual scragg mill capacity), in lieu of twenty four million board foot capacity which is the total mill capacity. For example, the costs per thousand board feet were calculated by dividing the total 2005 cost by 24,000 thousand board feet (MBF). These costs per MBF were then multiplied by 10,000 MBF in order to receive annual operating costs. The depreciation and taxes of the participating sawmill were used in calculating total annual operating costs.

The cost components used in this study, including a hypothetical $175/MBF log cost; adjusted fuel, marketing, and maintenance and repair costs are shown in Table 7. These cost components were held constant, except for fuel costs which varied with log diameter, and log costs which were systematically varied in the break even analysis.

Table 7. Hypothetical Sawmill Cost Components

Cost Component	Fixed (F) or Variable(V)	Cost / MBF
Log Cost	V	$175
Wages	V	$62
Residue Freight	V	$37
Repairs & Maintenance	V	$24
Fuel	V	$18
Contract Labor	V	$16
Health Insurance	V	$7
Utilities	V	$6
Supplies	V	$5
Payroll Taxes	V	$5
Equipment Rental	V	$2
Retirement	V	$1
Marketing	F	$20
Depreciation	F	$16
Interest	F	$11
Insurance	F	$6
Taxes	F	$4
Administration	F	$1

Raw material costs are the single largest cost component for sawmills. Given the amount of yield variation between log groups, average yield (8.8%) enabled comparisons of operating costs between log groups assuming an identical log cost. The average yield was calculated by dividing the total lumber and cant yield (7,097 BF) by the total log volume (6,518 BF). The required annual log volume was calculated for the average yield scenarios by dividing annual sawmill capacity, 10 million board feet, by the average yield. The required annual cant volume was calculated for the average yield scenarios by dividing annual pallet part mill capacity, 8 million board feet, by the average pallet part yield.

One of the underlying assumptions in the calculation of annual revenues and the comparison between log groups is that the annual production capacity, 10 million board feet, can be achieved using any of the log diameter groups in this study. The number of logs required for 6" group production is much greater than the number of logs required for 10" group production as shown in Figure 26.

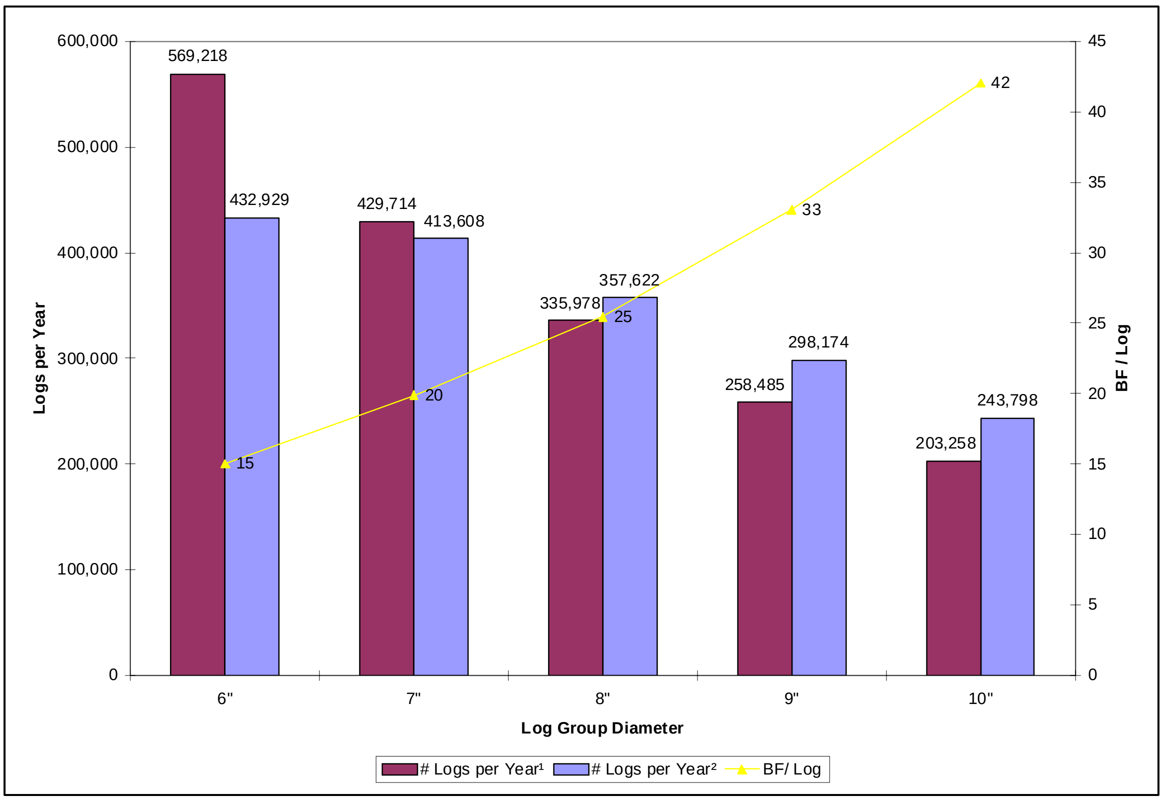

Figure 26. Log Requirements & Board Foot per Log Ratios [1] Avg. Yield [2] Act. Yield

The two estimates of the number of logs required to achieve annual production capacity are based on average yield and actual yield. The large variation in yield impacts the number of logs required and log cost. The exponential relationship between increasing volume per log as the log diameter increases has also been demonstrated by

Huber and Vasiliou (1968) and Barbour (1999). The increased number of logs, required for a constant level of production, also affects the production rate and sawing costs. The general trend is lower production rates occur and greater sawing costs accumulate as log diameter decreases (Howard, 1987). As cited previously, a scragg mill is designed to process small logs into cants and lumber at high feed rates so the machinery is capable of producing the requisite capacity.

In order to account for the additional material handling cost imposed by this empirical relationship, the fuel cost per MBF for each log group was adjusted according to the ratio of logs in that log group to logs in the 10" group. The ratios are calculated using the number of required logs per year (actual yield) as shown in Table 8. The original fuel cost for each log group was multiplied by these ratios resulting in adjusted fuel cost for each log group. For example, the adjustment ratio for the 6” log group was 432, 929 logs (Figure 26) divided by 243,798 logs, which is equal to 1.78.

Table 8. Ratios for Fuel Cost Adjustment

Log Group	# Logs Group X / # Logs Group 10"
6”	1.78
7”	1.70
8”	1.47
9”	1.22
10”	1.00

X = the xth diameter class

The variable operating and fixed costs, for the sawmill only after adjusting for fuel costs, are shown in Figure 27.

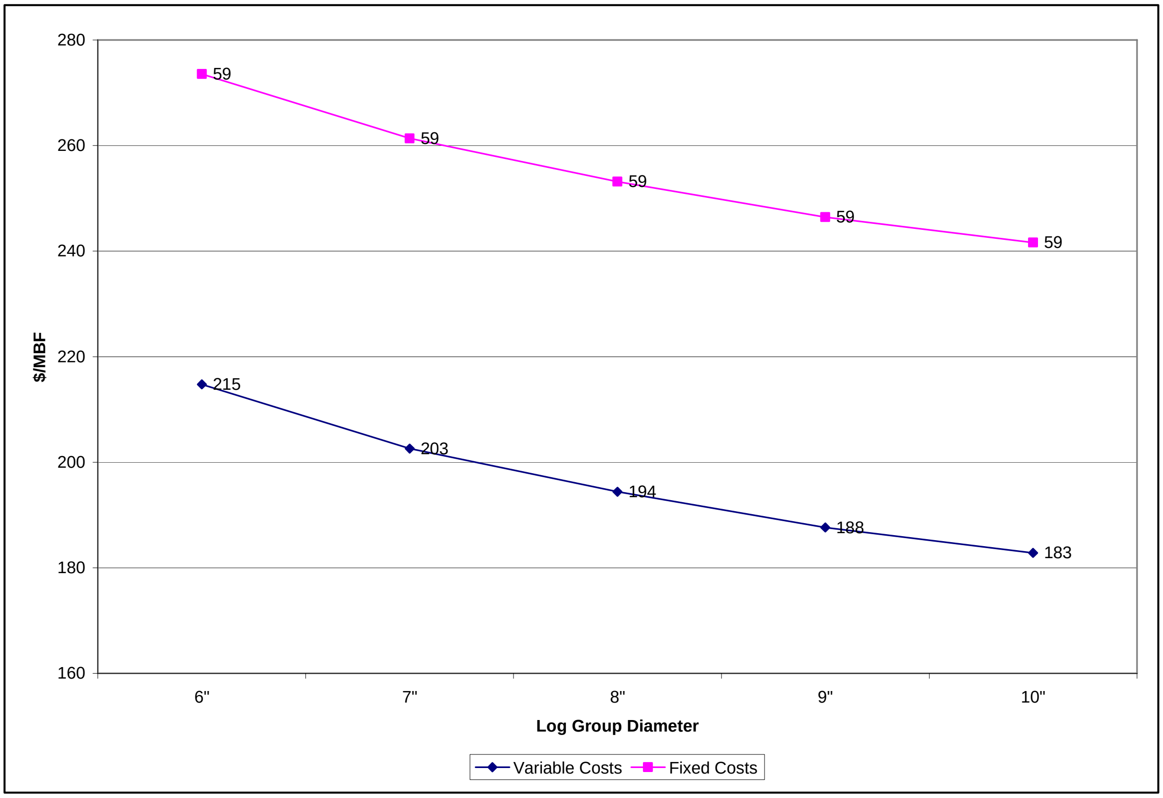

Figure 27. Sawmill Operating Costs

One additional adjustment was made to costs by transferring approximately one half of the maintenance and repair cost to marketing cost. This allocation was based on the assumption that a new sawmill using new equipment (as modeled in another section of this research) would have lower maintenance and repair costs as compared to the participating mill that had been in operation for 18 years. Furthermore, in order for a new business to be successful, it would need to allocate relatively more money to marketing and make marketing an important function of the company (Gruber, 2004).

3.2.4 Break Even Analysis

The break even analysis in this study compared the ratio of annual revenues to annual costs (revenues/costs) for each log diameter group under a number of different scenarios in order to determine which groups would be profitable. This analysis found which log diameter groups were profitable given variable conditions such as processing level, yield, and log cost. The log groups that were calculated to be both profitable (ratio > 1) and practical within the defined scenarios were pooled and used in the net present value and internal rate of return analysis. For this research, break even analysis compared the ratio of annual revenues to annual costs for each log group under 12 scenarios as shown below:

- Processing Level
  1. Sawmill
  2. Sawmill & Pallet Part Mill
  - Yield
    1. Actual Yield
    2. Average Yield
    - Log Cost
      1. $200/MBF
      2. $175/MBF
      3. $150/MBF

These scenarios were chosen for the following reasons. Since yield data on cants and pallet parts were collected, the comparison of a sawmill producing lumber and cants versus a sawmill and pallet part operation producing lumber and pallet parts was possible. This additional processing level could have an affect on feasibility. The actual yield and average yield were compared in order to determine if yield variations effect revenues and costs and furthermore, economic feasibility. As cited previously, log cost is the single largest cost component for sawmills and therefore it was systematically varied in order to estimate the delivered log cost payable by a mill utilizing small diameter logs.

3.2.5 Net Present Value & Internal Rate of Return

Net present value analysis compares costs and revenues over the project life by discounting them to present values. The net present value is the summation of all cash flows occurring during a project's life. A positive net present value means that the revenues over the project life are greater than the costs incurred during the project; and a negative net present value means that the costs are greater than the revenues. An economically feasible project will have a positive net present value. Internal rate of return analysis determines the rate that the project will return to the capital required to finance the project. The greater the rate of return, the more desirable the project becomes for investors. Net present value and internal rate of return analysis are the tools used in this research to determine the economic feasibility of a sawmill and pallet part mill utilizing red oak SDT.

Assumptions regarding the characteristics and operation of a small diameter timber sawmill and pallet part mill were needed in order to assess its economic feasibility. The initial assumption was that the hypothetical facility would utilize an equal volume of red oak logs from each log diameter group (i.e.: 6" - 10"). The logic for this assumption was derived from the objectives of this research, that a model for a sawmill and pallet part mill that can utilize SDT in Southwest Virginia was desirable. The next major assumption was that the revenues and costs of the hypothetical facility would not increase from year to year. In other words, the variables that influence revenues (i.e.: production capacity, yield, market prices) and costs (i.e.: wages, health care costs, transportation) were held constant over the project life of 30 years. This assumption was necessary so that the impact of log costs, yield and processing level could be revealed. In the business plan part of this research, the effects of capacity utilization, sales utilization and inflation were accounted for.

The NPV and IRR were calculated in Microsoft Office Excel (Microsoft, 2003) using net income from the various scenarios defined in the break even analysis section. The net incomes were calculated using the revenues and costs from each log group. An example of the net income calculation for the sawmill only, actual yield and $200/MBF log cost scenario is shown in Table 9. The revenues shown in Table 9 are the sum of revenues for this scenario from Table 6. The costs were obtained from the participating mill as previously described.

Table 9. Net Income Calculation

Revenues	
Cants	$2,021,599
2A	$1,015,373
1C	$455,575
Chips	$369,079
3A	$302,315
Sawdust	$148,913
Bark	$78,889
FAS	$44,229
1Face	$35,233
Total Revenue	**$4,471,206**
Costs	
Log Cost	$1,757,437
Salaries	$623,217
Residue Freight	$373,026
Fuel	$313,398
Repairs & Maintenance	$238,647
Marketing	$201,833
Contract Labor	$159,513
Depreciation	$155,533
Interest	$113,003
Health Insurance	$71,427
Insurance	$61,728
Utilities	$55,499
Supplies	$52,625
Payroll Taxes	$48,313
Taxes	$42,234
Equipment Rental	$19,694
Administration	$13,369
Retirement	$9,113
Total Cost	**$4,309,607**
Net Income	**$161,599**

The net incomes were assumed to occur every year for the project life. The net incomes are shown in Table 10.

Table 10. Net Income Scenarios

Processing Level	Yield	Log Cost / MBF	Net Income
Sawmill Only	Actual	$200	$161,599
		$175	$381,279
		$150	$600,959
	Average	$200	$209,634
		$175	$423,310
		$150	$636,985
Sawmill & PP Mill	Actual	$200	$559,911
		$175	$779,590
		$150	$999,270
	Average	$200	$607,946
		$175	$821,621
		$150	$1,035,296

The project life was set at 30 years based on two main factors: machinery useful life and depreciation. New sawmill machinery could last up to 30 years with proper preventive maintenance in a single shift scenario. The depreciation method used in the business plan part of this research allows for the depreciation of buildings for 30 years.

The discount rate used in NPV calculations was set at 10%. This discount rate is similar to long term industry averages reported by Hogaboam and Shook (2004). The discount rate reflects the cost of capital, whether it is sourced from creditors (debt) or investors (equity). Typically, investors require a greater return as compared to creditors. A method used to estimate discount rates is the weighted cost of capital. This technique enables firms to estimate a discount rate based on the proportion of debt and equity used to finance a given project and the respective required rates of return (Lang and Merino, 1993). The initial investment cost for the sawmill and pallet part mill are shown in Table 11.

Table 11. Initial Investment Costs

Description	Initial Cost
Sawmill Only	
Description	**Initial Cost**
Land	$800,000
Buildings	$526,777
Machinery & Equipment	$3,305,796
Working Capital	$1,087,614
Office Equipment	$19,413
Total	**$5,739,600**
Pallet Part Mill Only	
Description	**Initial Cost**
Buildings	$14,210
Machinery & Equipment	$296,222
Working Capital	$719,665
Total	**$1,030,097**
Total Sawmill & PP Operation	**$6,769,698**

The land and site preparation costs, including water, sewer and roads, were the product of $40,000/acre and 20 acres (Loftus, 2006). The initial costs of the buildings, machinery and equipment for both the sawmill and pallet part mill were calculated by appreciating the initial costs (supplied by the participating company) to 2005 dollars using a 4% discount rate. The working capital estimate was derived from the need to disburse payment for goods and services received during the first four months of the first year when sales are considerably below normal.

The calculation of net present value and internal rate of return were performed on Excel (Microsoft, 2003). The net present value is the summation of all cash flows occurring during a project's life. The cash flows are discounted to a designated year (year 0 or 1) and summed (Lang and Merino, 1993). This can be demonstrated graphically as shown in Figure 28.

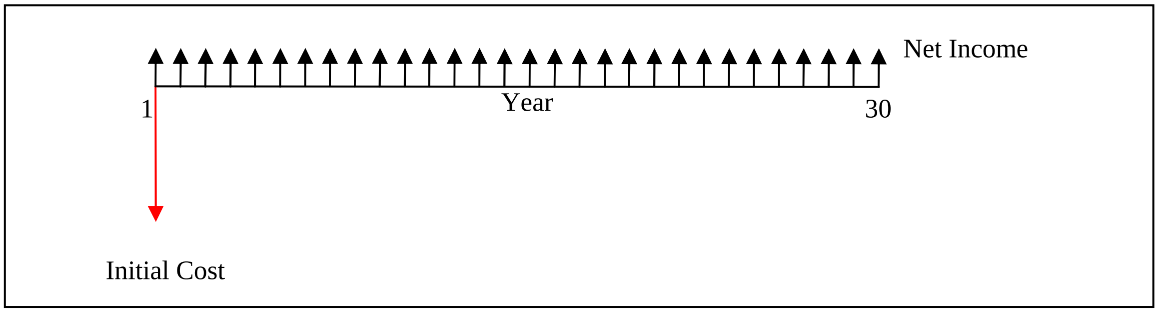

Figure 28. Net Present Value Diagram

The net incomes occurring in years 2 through 30 are discounted back to a year 1 value. The net income occurring in year 1 is then added to the other discounted net incomes and the initial cost is then subtracted from the aggregate net income. This result is the net present value of the project. A positive value indicates that the project is feasible and a negative NPV indicates that the project is not feasible given the assumptions and conditions set (i.e.: discount rate, project life).

The internal rate of return is the discount rate at which the net present value is equal to zero, at this level the discounted cash flows equals the initial investment cost. The internal rate of return will be greater than the discount rate if the net present value is positive and less than the discount rate if the net present value is negative. The internal rate of return is used by investors as a general indicator of project attractiveness (Lang and Merino 1993).

3.3.0 Results

The comparison of the actual yield revenue-to-cost (R/C) ratios (Figure 29) with the average yield R/C ratios (Figure 30) demonstrates the effect of yield on profitability. The six inch log group had an actual-yield R/C ratio greater than 1 in every log cost scenario, whereas, it had an average-yield R/C ratio less than 1 in the $200/MBFand $175/MBF log cost scenarios. This is due to the high yield of the six inch group (54% overrun) which decreased the cost of logs required to operate the mill at a constant production volume. The larger diameter logs (i.e.: 9" & 10") yielded more volumes of higher grade lumber, compared to the small diameter logs which is more valuable than the cants that account for the majority of the volume of the latter.

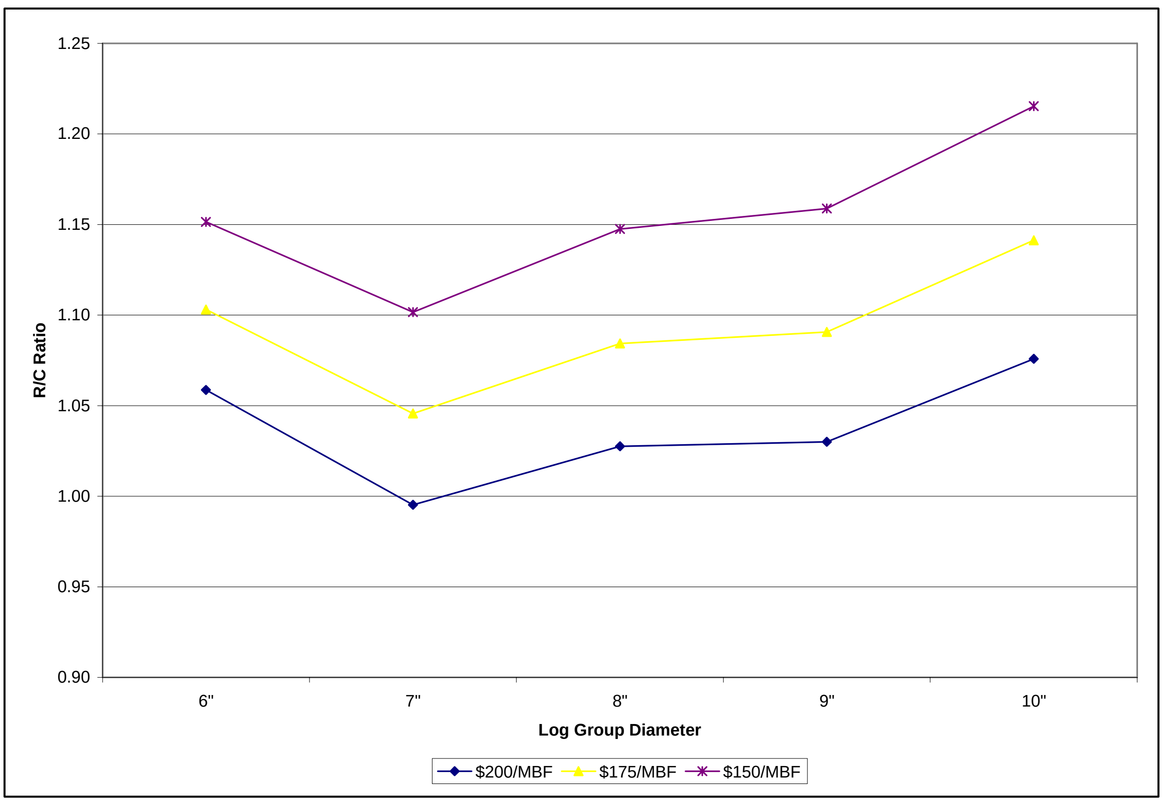

Figure 29. Sawmill R/C Ratios (Actual Yield)

The costs for the six and seven inch log groups exceed the revenues for the $200/MBF and $175/MBF log cost scenario as shown in Figure 30. Therefore, the hypothetical sawmill described in this study would not be profitable utilizing only 6” and 7” diameter logs in these scenarios. The trend was increasing profitability with increasing log diameter.

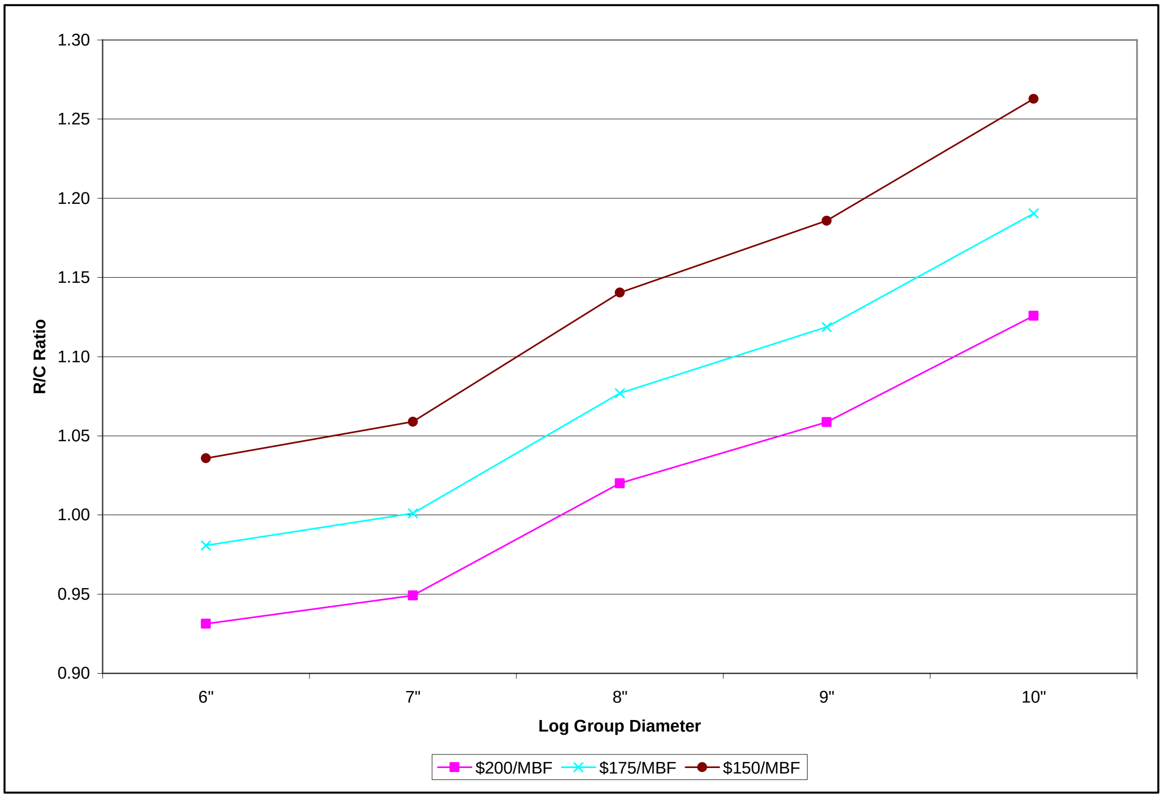

Figure 30. Sawmill R/C Ratios (Average Yield)

The effect of yield variation on profitability was evident at a greater processing level as indicated when comparing the trends shown in Figure 31 and Figure 32. The six inch log group, due to its high yield, exhibited a greater R/C ratio than the other groups. However, no common trend between diameter and profitability was found to be evident as illustrated in Figure 31. For example, the 6" log group had R/C ratios of 1.18, 1.15, and 1.12 for the $200, $175, and $150 per MBF log costs whereas the 10" log group had R/C ratios of 1.18, 1.14 and 1.10 for the same set of log costs. However, all log diameters were profitable at the sawmill and pallet part mill processing level.

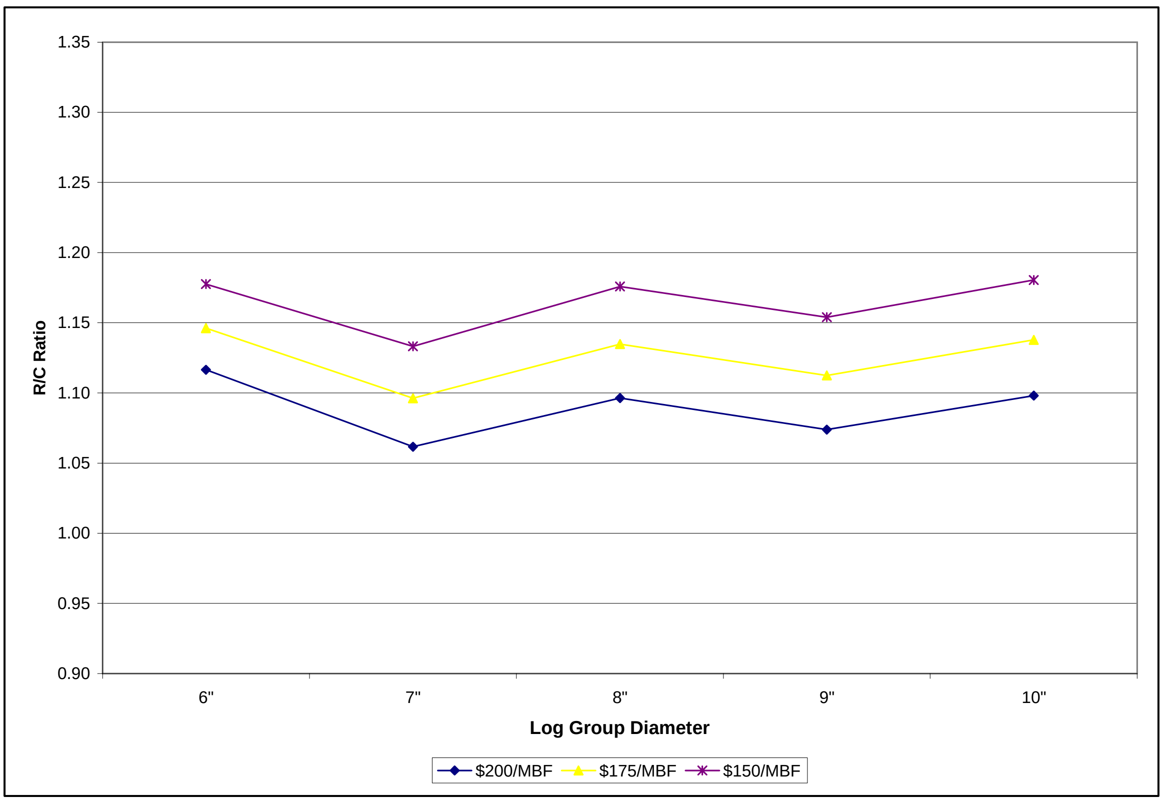

Figure 31. Sawmill & Pallet Part Mill R/C Ratios (Actual Yield)

The pallet part size yield is apparent in both Figure 31 and Figure 32. The eight inch log group had a total pallet part yield of 66% which was the most of all the log groups (See Figure 20). In addition, the pallet part length yield was 75% seventy-inch long parts which was the highest of all the log groups (See Figure 21). The seventy-inch parts sell for more than the other parts in the marketplace. These yield and market conditions result in comparatively larger revenues, which is evident in the deviation of the general linear trend (Figure 32).

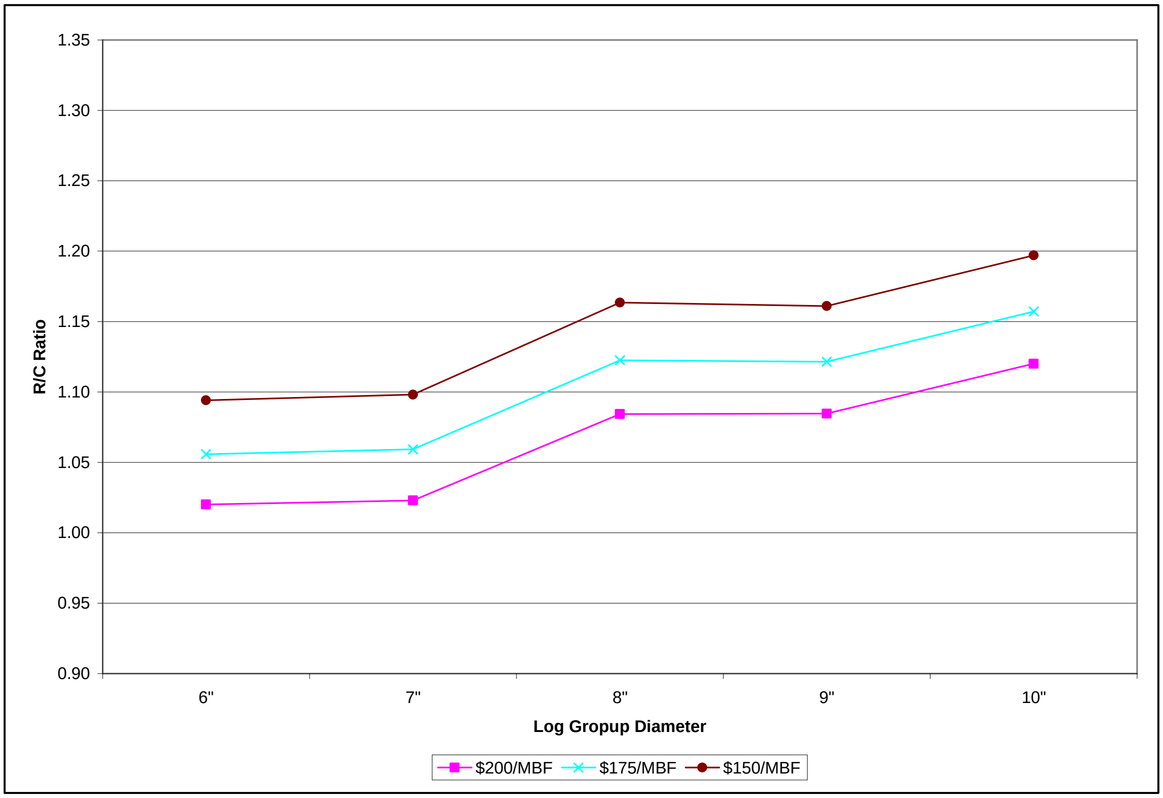

Figure 32. Sawmill & Pallet Part Mill R/C Ratios (Average Yield)

The net present values were all calculated to be negative and the internal rates of return were below the 10% discount rate for the sawmill only (scragg mill), actual yield scenario at all log costs as shown in Figure 33. The general trend is increasing economic feasibility with decreasing log cost. From this study, it was found that a SDT sawmill that solely produced lumber and cants only would not be economically feasible given the assumptions and conditions in this scenario.

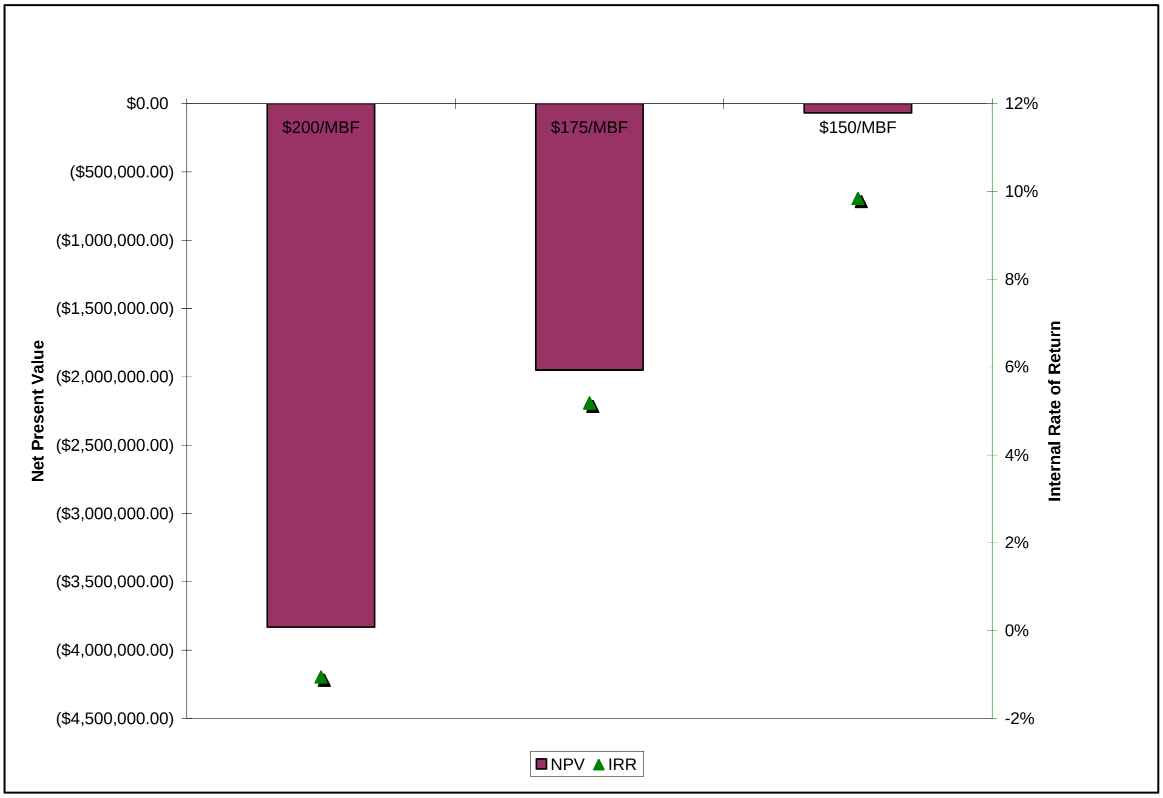

Figure 33. Sawmill NPV & IRR (Actual Yield)

The sawmill is not economically feasible under the average yield scenario at any log cost as shown in Figure 34 .

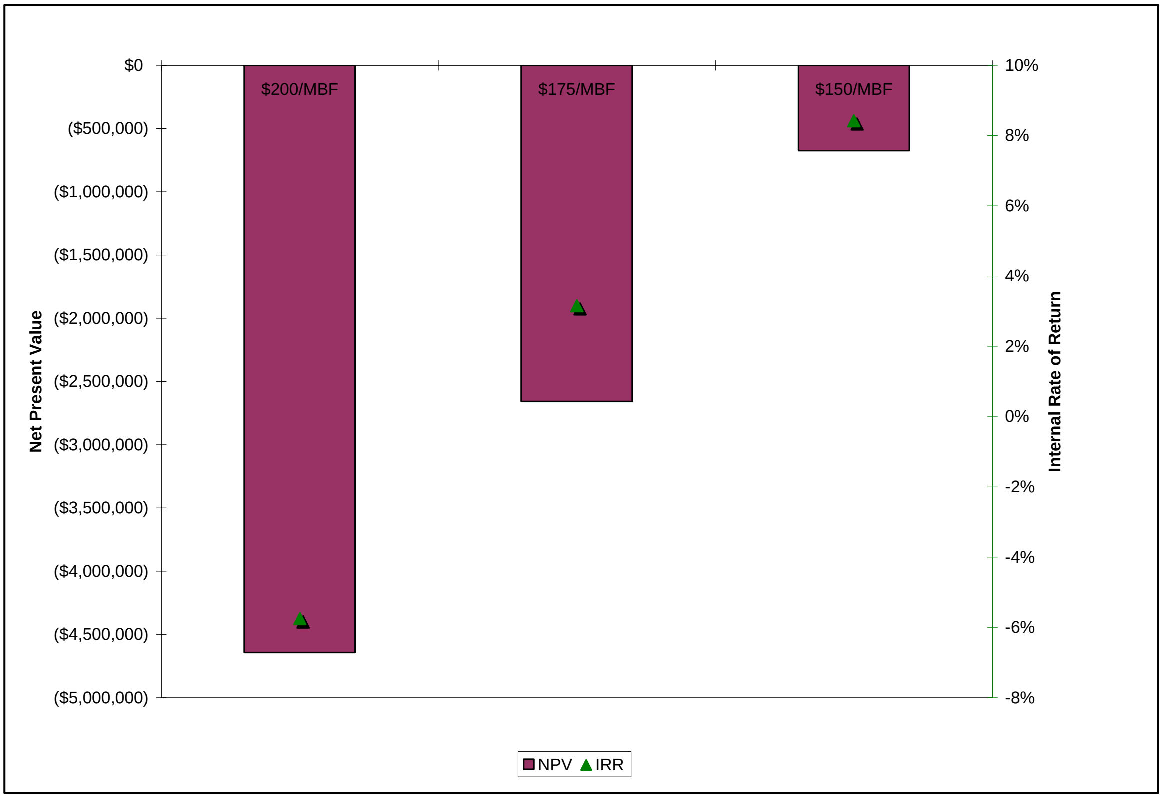

Figure 34. Sawmill NPV & IRR (Average Yield)

The effect of processing level (i.e.: more value added processing) on economic feasibility is evident as the net present values are positive for the $175/MBF and $150/MBF log cost scenarios (Figure 35). The transformation of cants into pallet parts increases the value of the material which in turn increases revenues and profitability. This increased profitability at a greater level of processing increases the economic viability given these conditions. The $175/MBF delivered log cost is equivalent to $35/ton and this price competes favorably with pulpwood prices. Therefore, the $35/ton delivered log cost, actual yield scenario was used in the business plan portion of this research.

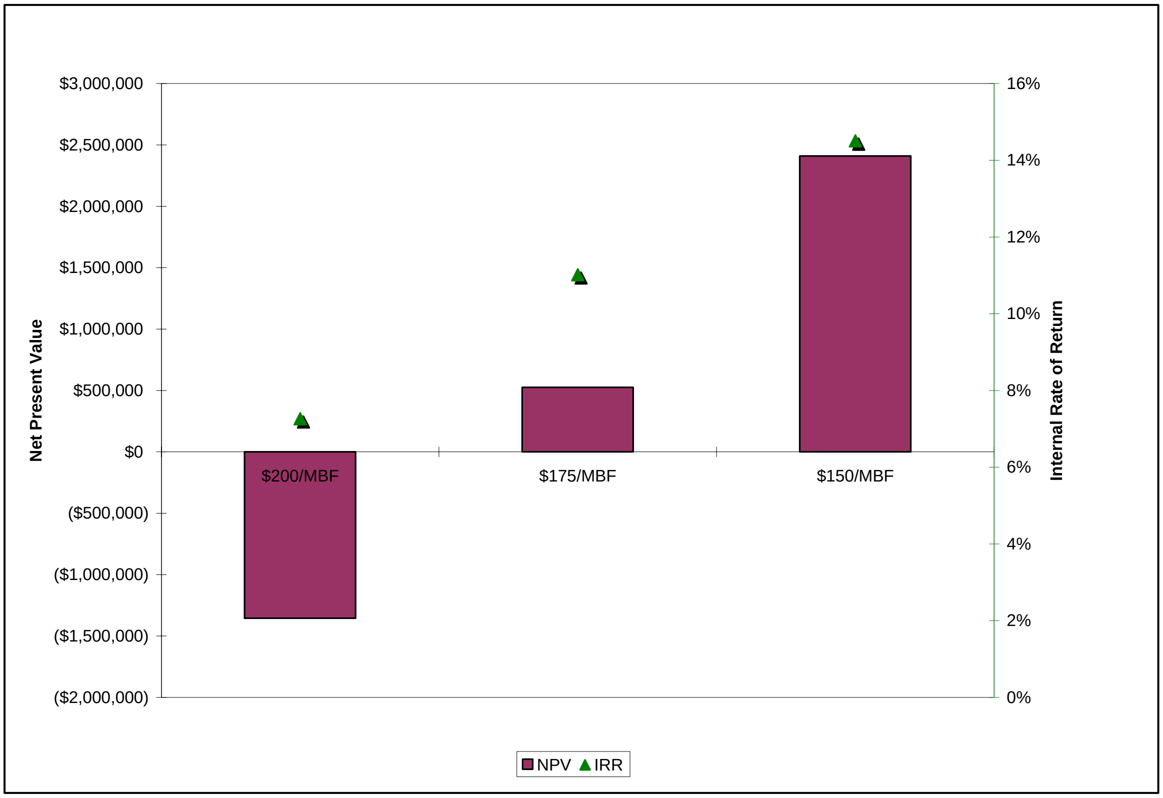

Figure 35. Sawmill & Pallet Part Mill NPV & IRR (Actual Yield)

The sawmill and pallet part mill, average yield scenario is not an economically feasible scenario. The internal rate of return is less than the discount rate and the NPV is slightly negative. (Figure 36).

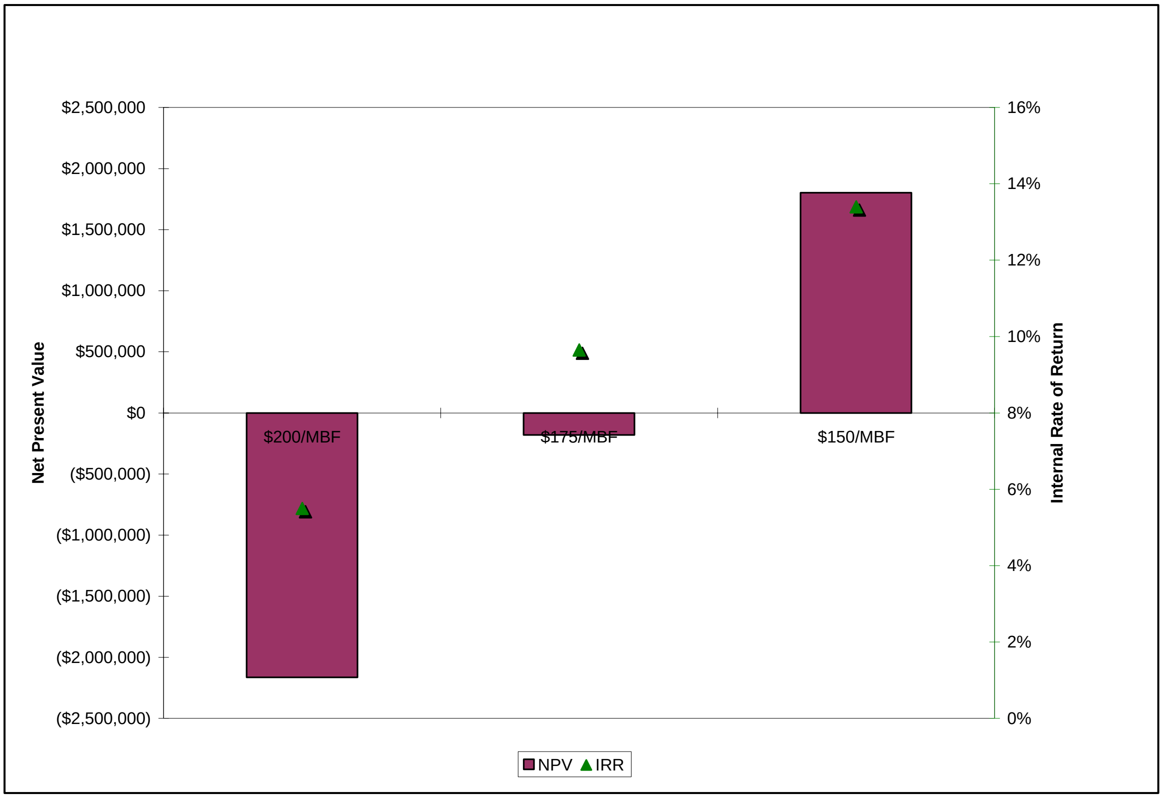

Figure 36. Sawmill & Pallet Part Mill NPV & IRR (Average Yield)

3.4.0 Discussion

The intent of comparing hypothetical scenarios is to determine which variables, log diameter yield, log cost, and processing level, are most critical in determining profitability and economic feasibility of a SDT sawmill and pallet part mill. The break even analysis compared the different scenarios in order to determine which log diameter groups would be profitable given different assumptions.

In the yield study, the two-sided cants were sawn into 3" thick cants and 1-inch thick lumber. The log diameter yield is critical at the sawmill-only processing level because the smaller diameter groups (i.e.: 6" - 8") yield mostly cants whereas the larger diameter groups yield proportionately more volume of higher grade lumber. The market price for cants is lower than lumber and given the operating costs, the overall result is that profitability decreases with decreasing log diameter.

Any conclusive relationship between profitability and log diameter at the sawmill-pallet part mill processing level is obscured due to the actual yield variation. Given the annual capacity of the pallet part mill, 8 million board feet, and the pallet part yield, some cants must be purchased on the market (Table 12).

Table 12. Cant Volume & Costs

Log Diameter Group	Cant Volume (MBF)	Cant Cost
6"	5,210	$1,628,260
7"	5,313	$1,660,440
8"	5,699	$1,780,944
9"	6,620	$2,068,630
10"	7,297	$2,280,300

The volume of cants that must be purchased increases as the log diameter increases due to the initial log yield and therefore increases the raw material costs of the cants. In turn, the total pallet part mill costs increased as log diameter increased and this affects the R/C ratios. The average yield R/C ratios had a positive linear trend between log diameter and profitability, which is a factor of constant log costs and increasing revenues.

The break even analysis results indicated that all log diameter groups could be profitable given the actual yield, for the sawmill and pallet part mill scenario. Therefore, the economic feasibility analysis was conducted assuming equal volumes of all log group diameters.

McCay and Wisdom (1984) reported a positive net present value and a 23% IRR for a scragg mill using low quality small diameter hardwoods. The authors assumed a 10 year project life and a 15% discount rate. Lin et al (1995) reported a positive NPV and 27%+ IRR for a direct conversion, dimension plant utilizing grade 2 and 3 red oak logs. The authors assumed a 12% discount rate and 10 year project life.

The economic feasibility analysis illustrated that the sawmill-only (scragg mill) processing level scenario is not economically feasible under any hypothetical conditions. Economic feasibility increased as log cost decreased but all scenarios at the sawmill-only processing level were found to be not feasible.

The actual yield, sawmill and pallet part mill scenario was found to be economically feasible at a $175/MBF log cost. The NPV was calculated to be over $500,000 and the IRR was approximately 11%. The actual yield, sawmill and pallet part mill scenario should be able to attract the requisite capital from investors. Therefore, this scenario is used in the business plan portion of this research.

3.5.0 Summary

The actual yield values obscured any relationship between profitability and log diameter at the sawmill-only and the sawmill and pallet part mill processing level scenarios. The average yield values indicated that larger diameter logs would be more profitable than smaller logs due to lower operating costs and yield of more valuable products (i.e.: lumber). The sawmill and pallet part mill processing level scenarios are more profitable as indicated by greater R/C ratios. All log diameters were profitable under the sawmill and pallet part mill actual yield scenario, therefore, the economic feasibility analysis assumed the utilization of all log diameters.

The sawmill-only processing level scenario was found to be not economically feasible given the specified conditions and assumptions. The sawmill and pallet part mill, actual yield scenario at $35/ton delivered log cost was economically feasible. This scenario formed the basis for the development of the business plan.

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4.0 Business Model

4.1.0 Introduction

The business model in this research is a sawmill and pallet part mill producing lumber, pallet and container parts, and residues. The novelty of this situation is that this research discovered that 6"-10" red oak SDT logs purchased at $35/ton can be economically utilized with certain limitations in that business model. The purpose of this section is to further develop that inherent business model into a specific business plan that could be useful to researchers and industry.

A business plan is necessary to attract financing for start-up or expand a business. Well-written and realistic business plans act as a roadmap for the successful implementation of a business idea. The business plan presented in this section contains the following sections and generally follows the outline provided by Howe and Bratkovich (1995):

1. Introduction
2. Industry Overview
3. Product & Process
4. Marketing Plan
5. Operating Plan
6. Financial Plan

The introduction gives a brief overview of the company's purpose and financial summary. The hardwood lumber industry and its current situation is reviewed and the product and process is described in the third section. The marketing plan consists of a market analysis, market survey, marketing strategies and sales forecasts. The operating plan describes the company's location, employees, raw materials and production. The financial plan includes *pro forma* financial statements, the capital requirements and an economic analysis.

4.2.0 Methods

The methods, assumptions, and conditions described herein are temporal and contextual in nature. The business plan will enable the researcher, entrepreneur, or business owner for further research, implementation, or business modification purposes. A general description of the methods, assumptions, and/or conditions utilized to construct the last four segments of the business plan follows.

The product description is based on the results of a yield analysis and the two primary target markets: flooring and pallet and container manufacturers. The process description is based on the machinery types used by the participating mill, except for the use of wheeled loaders, which are used to move logs. The hypothetical mill would utilize a log crane for transporting logs from storage to the mill.

The marketing plan follows Howe and Bratkovich's (1995) recommended format with the exception that the specific action steps and feedback and control sections were replaced with a more general implementation section. The SWOT analysis consisted of a meta-analysis of government and industry data, news, and industry publications.

The market survey consisted of a phone interview of potential customers for low grade lumber, pallet and container parts, and residues. Directories and databases was used to contact flooring, pallet, furniture frame, and dimension manufacturers, along with wood residue users (sawdust, chips, and bark) within Virginia and surrounding states. The questionnaires for solid wood and residue customers are shown in Appendix A & B.

The sales forecast assumed that 90% of the capacity utilized in the first year would be sold. The sales utilization drops to 85% in the second year, increases to 95% in year 3 and 100% in year 4 through 30. The hypothetical sales utilization is shown in Figure 37. The capacity utilization is assumed to increase gradually over the first 4 months. The first month's capacity is 40%; 56% in the second month; 70% in the third month; 84% in the fourth month; and 94% in the fifth month. The remainder of the year is assumed to achieve 94% capacity utilization each month and the average for the first year is 83%. The company must achieve high capacity utilization rates to be competitive in the industry. The capacity utilization is assumed to be 95% for the entire project life as shown in Figure 37.

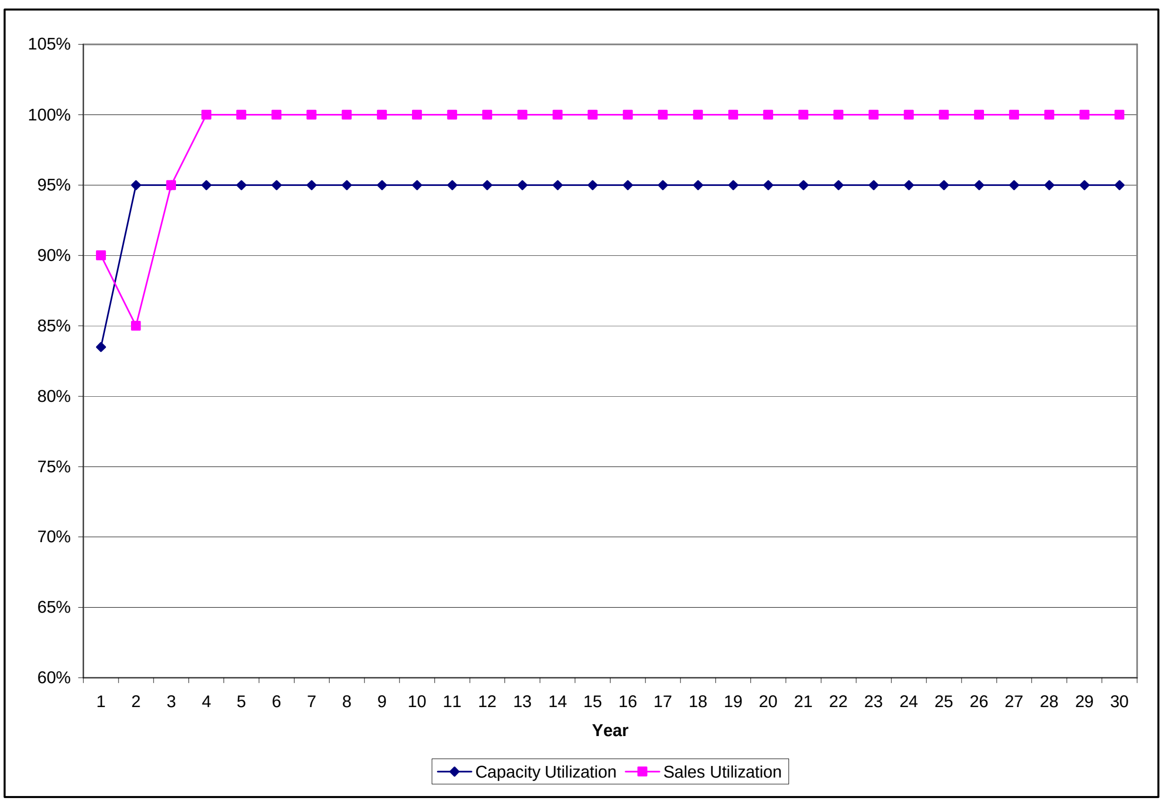

Figure 37. Capacity & Sales Utilization

The operating plan contains descriptions of the company's location, employees, raw materials and production schedule. The location of the facility was based on access to an adequate volume red oak SDT and target markets. The required labor force was derived from machine requirements and budgeted from the participating mill's labor costs. The requisite log volume was established from the yield analysis. The delivered log costs are $35/ton; logs are weight scaled; and residue freight costs are $10/ton.

The financial plan includes *pro forma* financial statements, the capital requirements and an economic analysis. The assumptions in the financial plan include: 30 year project life; $6.8 million initial cost (Table 11); and a debt/equity ratio equal to one. The debt to equity ratio is derived from the wood product industry average in 2002 (IRS, 2006). The initial financing is assumed to be 50% debt and 50% equity.

The *pro forma* financial statements are based on the sales forecast, which in turn is dependent upon the capacity utilization. The Modified Accelerated Cost Recovery System (MACRS) is used as the depreciation method (IRS, 2005). The *pro forma* financial statements assume that the company will not pay any federal or state income tax. The Virginia forest products tax is paid by the company. The revenues and costs are assumed to be subject to inflation each year by a rate of 2%. This is based on the industry average from 1980 to 2005. (BLS, 2006). The loan repayment starts in year one and the equity repayment begins in year two. The economic analysis is based on the actual net income, which is derived from the sales and capacity utilization forecasts and the MACRS depreciation.

4.3.0 Business Plan

4.3.1 Introduction

Southwest Custom Hardwoods, the name of the hypothetical company, would utilize red oak small diameter timber (SDT) to produce lumber, pallet and container parts, and residuals for industrial markets. The literature review and the results of the yield analysis showed that SDT would yield mostly low grade lumber, cants, pallet and container parts, and residues. These markets are comparatively healthy as compared to other segments of the industry such as furniture frames manufacturers.

The lumber would be graded and suitable for use in the hardwood flooring industry which has over 100 establishments that consumed approximately $500 million of hardwood lumber in 2002 (U.S. Census Bureau, 2005a). The pallets and container parts, accounting for the majority of production, are made to customer specifications for pallet and container manufacturers. The wood container and pallet industry had over 2,700 companies that consumed approximately $470 million of hardwood lumber in 2002 (U.S. Census Bureau, 2005b). The hypothetical company seeks to add value to the forest resource in Southwest Virginia by providing rewarding careers; actively participating in the community; and profitably producing wood products.

The hardwood lumber industry provides solid wood products to industrial markets such as furniture, flooring, cabinetry, pallet, millwork, railway tie and dimension manufacturing sectors. The industry also supplies sorted wood residues such as chips to paper and fiberboard manufacturers; sawdust to particleboard manufacturers and bark to landscapers. The industrial market segments are driven mainly by housing starts, remodeling, and transportation demand, while the wholesale and export markets are affected by additional variables. There are three hardwood scragg sawmills that produce lumber and cants in Southwest Virginia. There are two pallet stock manufactures in the region.

A $6.8 million initial investment would be sought for the construction and start-up of a state-of-the-art, high speed, small log sawmill and pallet part plant. This includes four months of working capital, which should be an ample contingency. The company would be financed with 50% debt and 50% equity, which was based on the wood products industry average. The financial goals are to become profitable in the third year; remain profitable throughout the project; and increase the worth of the company to the owner(s), employees, and community as a whole.

4.3.2 Industry Overview

The lumber industry has evolved over thousands of years from the earliest attempts by the ancient Egyptians with bronze saws to the Swedes' invention of pit sawing in 1250. The industrial revolution brought water-powered and steam-powered sash gang saws and then the band saw was invented in 1850 (Williston, 1988). The industry's productivity and efficiency continued to develop in accord with the industrial revolution. Once the large timber throughout the U.S. was utilized, there was a shift to using relatively smaller logs and this trend will continue. The company is positioning itself to take advantage of the shift to smaller logs.

The hardwood lumber industry is highly fragmented, mature, and pro-cyclical. The hardwood lumber industry has over 2,000 companies that produce between ½ million BF and 50 million BF per year (Luppold, 2006). The growth in housing construction and transportation has been the primary driver for growth in the hardwood lumber industry during the last century. The hardwood lumber industry is susceptible to economic fluctuations as shown in the production of hardwood lumber (Figure 38).

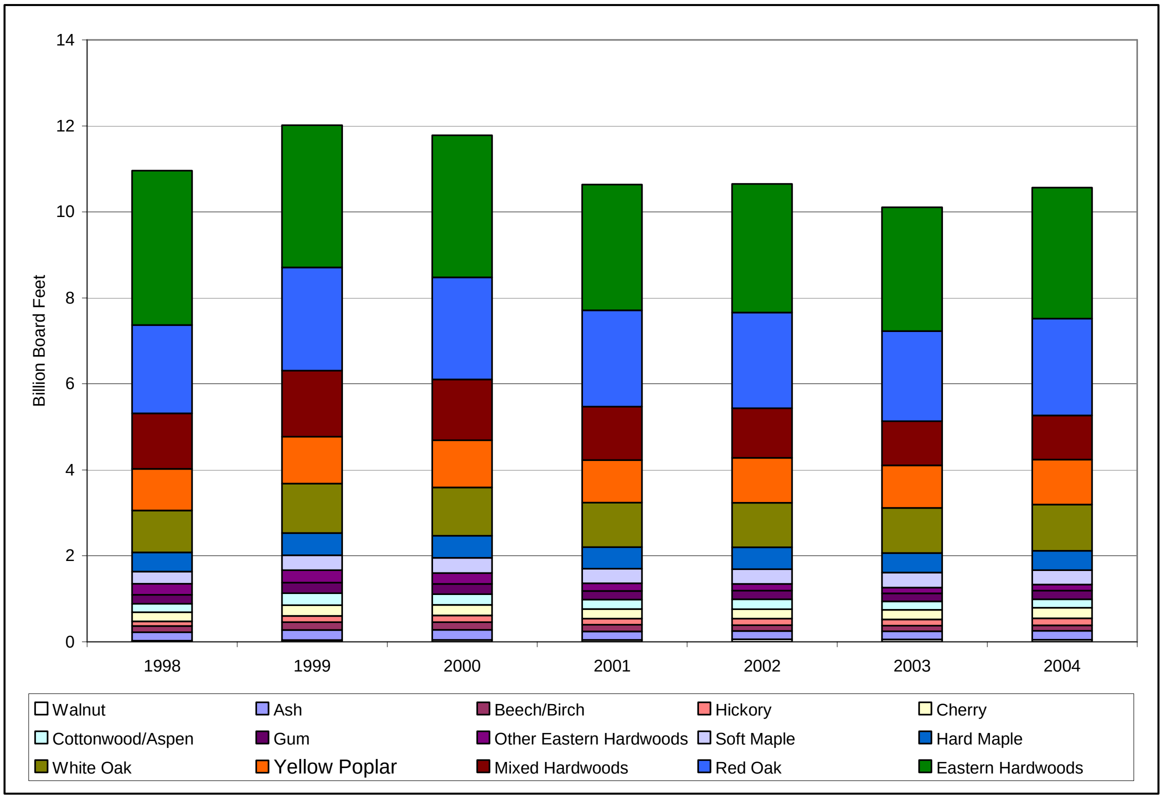

Figure 38. Hardwood Lumber Production U.S. Census Bureau, 2005c.

The trends within the industry include an increased use of technology, mill consolidation, increased value addition, changing markets and customers, and increasing labor, transportation, and insurance costs. Research and development performed by the hardwood lumber industry to mitigate and respond to these trends is limited. Most research and development is funded by the federal government and performed by universities and research centers.

The key success factors for the hypothetical business include: the ability to utilize low quality, low value, small diameter logs and convert them into products less costly than competitors; the balance between a marketing and production orientation that enables the business to meet customer-specific requirements while achieving high capacity utilization rates; and the motivation of employees to seek continuous improvement of the business and themselves through training, education and active participatory management. These success factors equate to the competitive advantages the business has over competitors. The new machinery and market orientation will create a nimble, responsive organization that can easily respond to customer demands for custom sizes and grades. The utilization of SDT and the elimination of log scalers and wheel loaders is an advantage over other hardwood lumber producers.

4.3.3 Product & Process

Southwest Custom Hardwoods produces three main products in order of decreasing market value and volume: pallet & container parts, lumber, and wood residues. Lumber and wood residues are commodity products with selling prices largely determined by the marketplace. The strategy for pallet and container parts is to make custom sizes and grades, which will command a higher price than commodity pallet and container parts. A description of each product group is presented to differentiate them and an outline of the manufacturing process is discussed.

The lumber will be graded in accordance to the National Hardwood Lumber Association's (NHLA) grading rules. The company will produce 1-inch thick lumber that will be sold green, random length, random width in truckload quantities. The lumber will be sold directly to flooring manufacturers, dimension manufacturers and wholesalers as needed. Approximately 3.5 million board feet (BF) of lumber will be produced each year. The associated yield analysis indicated that most of this lumber would be 2A with lesser amounts of 3A and 1C produced.

The wood residues will be sorted and stored as separate products. The wood residues will be delivered by the company to the customer. The company will incur the cost of freight. The chips will be high quality as required for pulp, paper and fiberboard manufacturing. The sawdust will be sold primarily as boiler fuel; for the manufacture of particleboard; and to local agricultural users. The bark will be sold as mulch to local consumers and wholesalers.

The pallet and container parts will be made to custom sizes and grades. The parts are generally less than 1-inch thick with the exception of pallet stringers that are 1 3/8" thick. The parts will be used by the company's customers to construct pallets and containers. The parts are stacked and bundled by size and grade and sold in quantities demanded by the customers.

A diagram of the manufacturing process showing machine centers and products is shown in Figure 39. The logs are fed onto the log in-feed deck before passing through the a metal detector, cross-cut saw, and ring de-barker. The logs are sent to a surge deck that feeds the scragg mill. The scragg mill grabs the logs by the ends and passes them through two saws in order to produce a two sided cant. The cant is then fed through a gang saw which produces 1" thick boards and a cant. The boards are processed through the edger and end trimmer before being graded and stacked as lumber. The cants are sent to the pallet and container part operation where they are cross-cut to length and then processed through a gang saw into pallet and container parts before grading and stacking. Converting logs to lumber generates bark at the de-barker and chips and sawdust at every machine center. The finished lumber and part packs will be tallied and bar coded. The inventory will be kept by the forklift operator and mill supervisor.

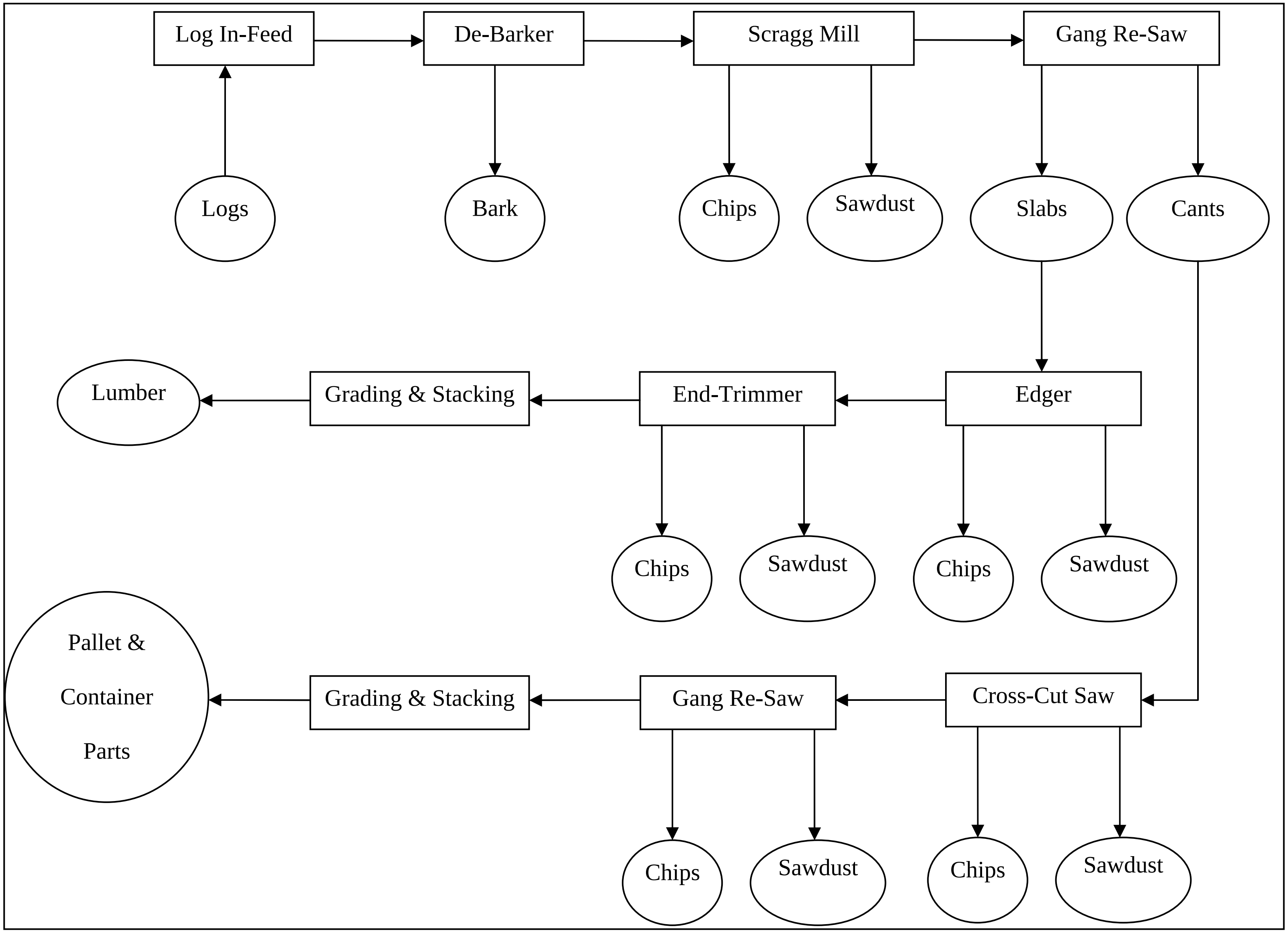

Figure 39. Manufacturing Process Diagram

4.3.4 Marketing Plan

Current Market Situation

This section describes the company, its competition and its customers. Since the company is hypothetical, a generic description of customers and the company is presented. Potential competitors within the defined Southwest Virginia region are reviewed.

The company utilizes red oak small diameter timber in order to produce lumber, pallet and container parts, and residuals for industrial markets. The lumber, accounting for 1/4 of sales, is NHLA graded and suitable for use in the hardwood flooring industry. The pallet and container parts, accounting for the 2/3 of sales, are made to pallet and container manufacturers specifications. The wood residues, accounting for approximately 8% of sales, are sold primarily to the paper, fiberboard, energy and landscape markets. These markets are comparatively healthy as compared to other segments of the industry (i.e.: furniture frames). However, red oak lumber prices are currently depressed; energy prices are volatile and the pallet and container market is dependent on the overall economy.

The amount of lumber used in the flooring sector has increased from 1.4 billion board feet (BBF) to 1.6 BBF in 2004 (Figure 40). The amount of lumber and cants used in the pallet sector has decreased from 4.5 BBF in 1999 due to an increase in pallet recycling and repair but it has held steady at 4 BBF since 2001. The amount of wood residues is difficult to quantify but the there has been an over increase in the value of hardwood chip shipments as shown in Figure 41. The Virginia shipment value increased from $20 million in 1997 to $24 million in 2002.

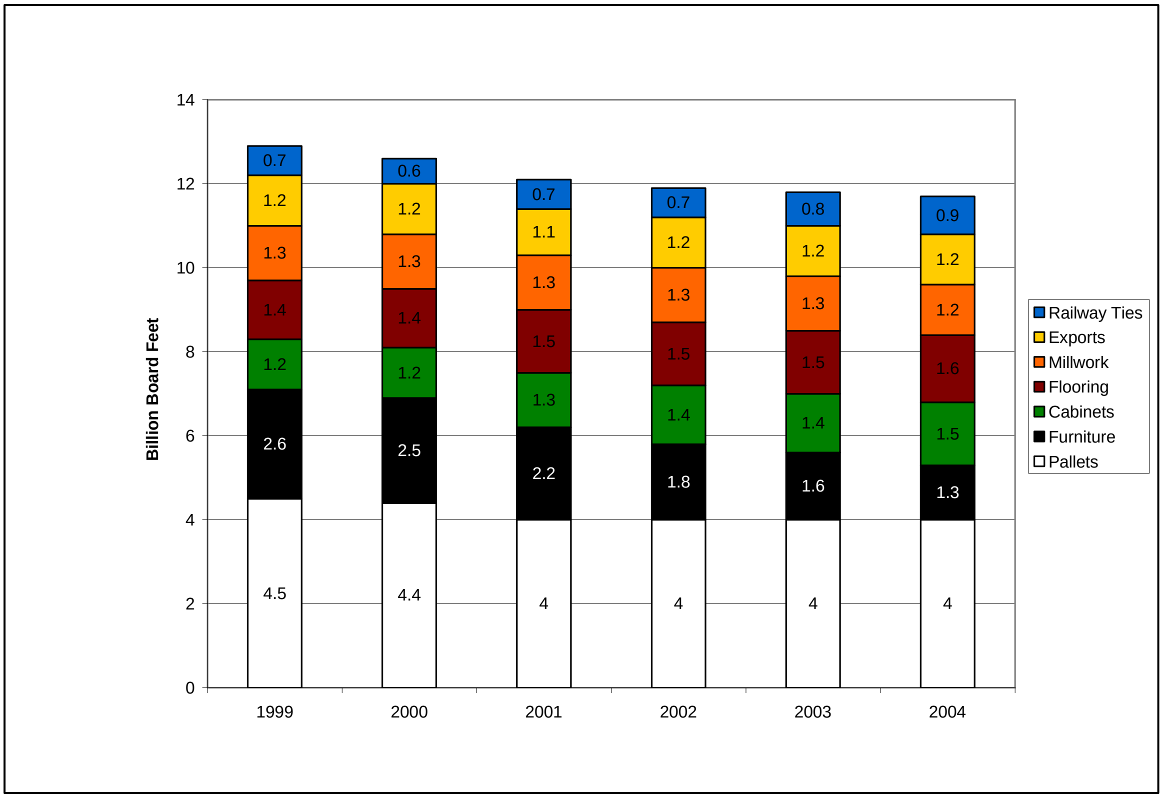

Figure 40. Hardwood Lumber Consumption by Market Segment Hardwood Market Report, 2005

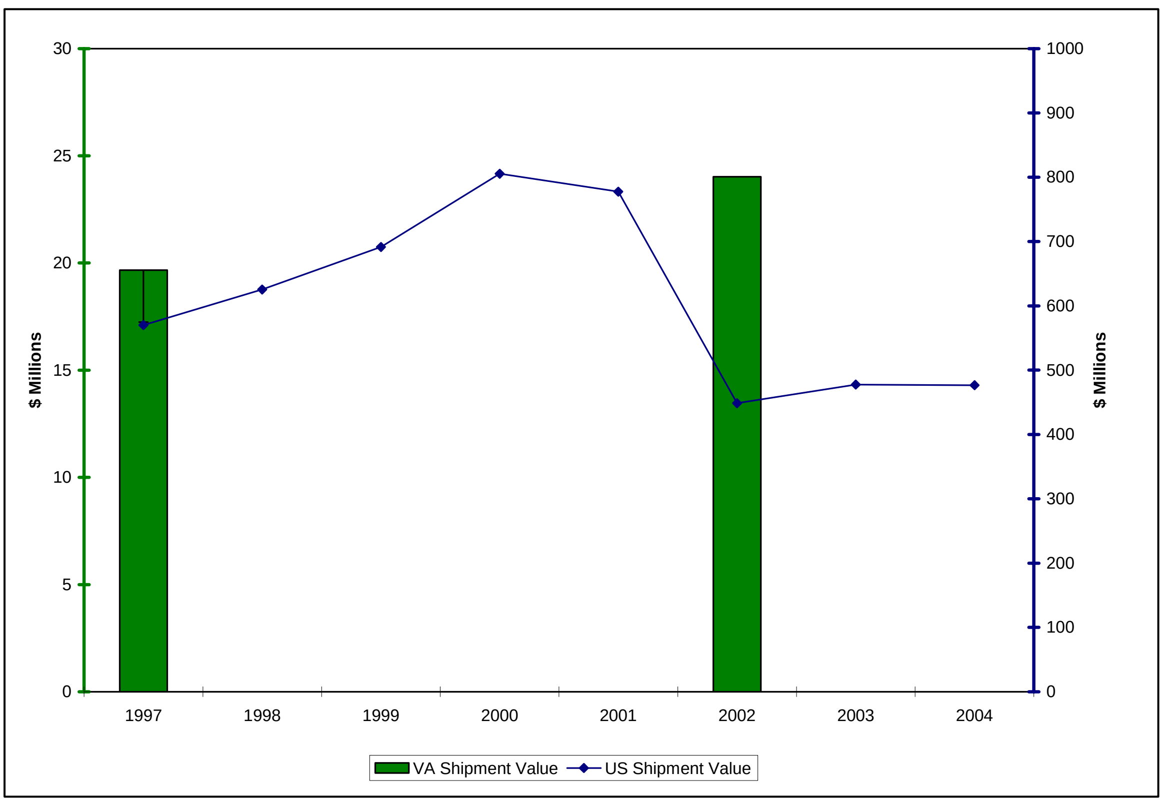

Figure 41. U.S. & V.A. Hardwood Chip Shipment Value U.S. Census Bureau, 2003 & 2005d & 2005e

SWOT Analysis

The SWOT analysis for Southwest Custom Hardwoods consists of strengths, weaknesses, opportunities and threats (SWOT) analysis. The strengths and weaknesses are an analysis of the characteristics of the company while the opportunities and threats are an analysis of the market environment.

The strengths of the company include access to ample low cost raw materials; a new production facility; a marketing orientation; and excellent customer service. The logs utilized by the company will be purchased for $35/ton, which is less than most of the competitors who buy sawlogs. The design of the new production facility will optimize throughput while enabling fast product changes. The commitment of the company to being market oriented and providing high quality customer service is required in the competitive environment.

The weaknesses of the company include an unknown brand; potentially low product quality; and lack of market diversity. As a startup, the company will have to work hard to develop its brand in the marketplace. The importance of producing high quality products in the first few months of production will continuously motivate the workforce. The lack of market diversity, that is the focus on the flooring and pallet and container segments, will encourage the marketing department on acquiring and keeping the targeted customers.

The opportunities discovered by the market survey include steady and increasing lumber and pallet part usage by the flooring and pallet segments, respectively. The market survey also described the needs of potential customers (dimension, flooring, pallet, and furniture frame manufacturers along with wood residue users) and future product demand (Figure 42). This indicated that the majority of furniture frame manufacturers and wood residue users predicted no change in the quantity of products that they would consume. Forty-three percent of dimension manufacturers saw no change in their future purchased lumber volume with the remainder being evenly split. Fifty percent of flooring manufacturers believed that they will increase or not change their future purchased lumber volume and the other fifty percent believed that they will decrease or not change their future purchased lumber volume. The majority of pallet manufacturers indicated that they will increase or not change the amount of pallet parts and cants that they purchase.

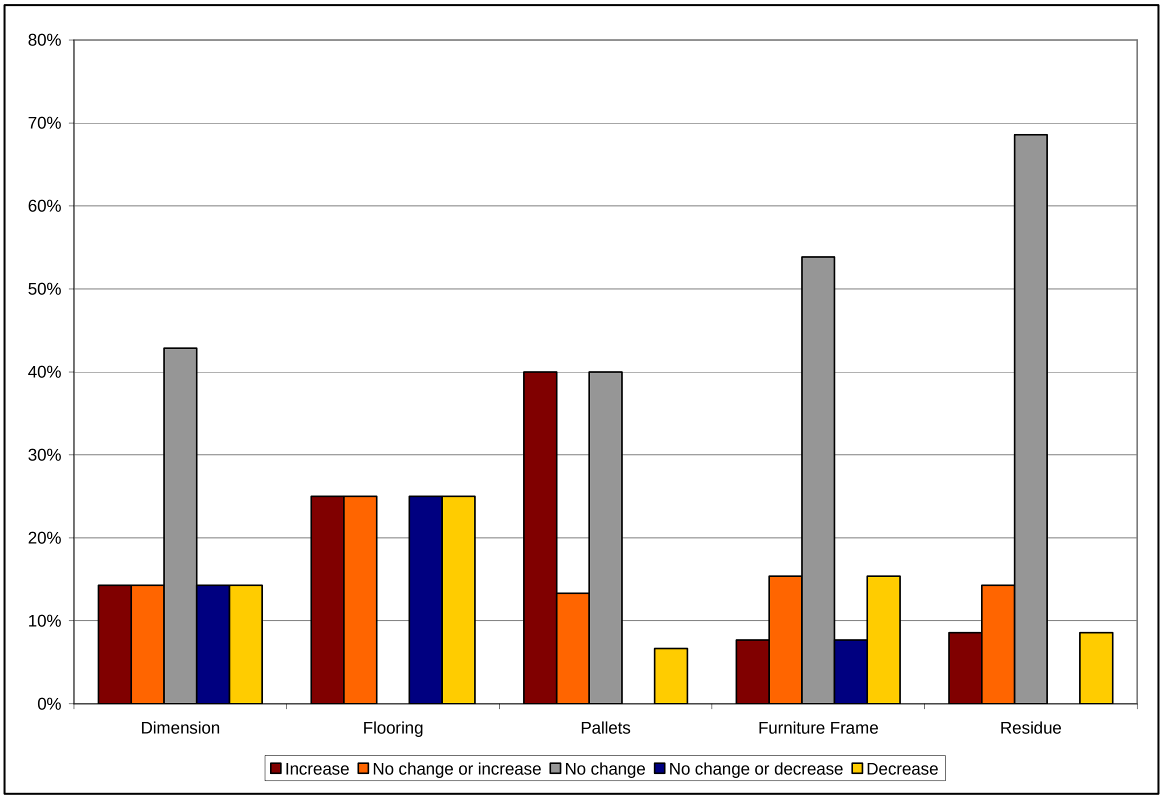

Figure 42. Future Product Usage by End Using Segment

The market analysis showed a trend toward increased use of hardwood flooring, and the steady growth in pallet demand. The shipment volume of hardwood flooring in the residential housing sector has increased since the early 1980s due to new home construction and remodeling demand along with consumer preferences (Hardwood Market Report, 2005). The increase in trade and commerce should increase the demand for wood packaging materials.

The major threat to the company is a decline in their customers' markets, which could be caused by a loss of markets share to substitutes; a general decline in competitiveness as compared to foreign imports or general economic conditions. Solid wood flooring substitutes include engineered wood flooring; laminate flooring and ceramic flooring. The ease of installation associated with engineered wood flooring is being addressed by solid wood flooring manufacturers by pre-finishing their flooring. The hardwood lumber industry has also undertaken a domestic, solid-wood promotion campaign (HMA, 2006).

Hardwood pallet and container part substitutes comprise softwood lumber, structural panels, and engineered wood parts, along with plastic and corrugated pallets and containers. The emergence of softwood lumber and engineered wood pallet and container part utilization could be due to greater yield and lack of hardwood supply. However, hardwood pallet and container parts, which are sold green, generally have a price advantage over softwood lumber and engineered wood products. The threats from global competition and economic conditions are beyond the control of the hypothetical company. The company must focus on its strengths and the opportunities in the market in order to achieve it goals.

Goals & Objectives

1. Achieve $5 million in sales in the 1st year.
2. Sell 90% of production in the 1st year.
3. Increase sales to $6 and $7 million in year 2 and 3, respectively.
4. Retain all of the most profitable customers.
5. Establish relationships with flooring and pallet and container manufacturers.

Marketing Strategies

The marketing strategies differ for the three distinct product categories produced by the company: pallet and container parts, lumber, and wood residues. Lumber and wood residues are commodity products with selling prices largely determined by the marketplace. The strategy for pallet and container parts is to make custom sizes and grades, which will command a higher price than standard commodity pallet and container parts. The marketing focus should be on the main product, pallet and container parts, while lumber and residuals are of secondary importance.

The target market for pallet and container parts is pallet and container manufacturers that require non-commodity, specialty parts. The market survey of pallet and container manufacturers in Virginia and surrounding states showed an average lumber purchase volume of over 4 million board feet (Table 13). The pallet and container parts are positioned so that they command a premium in the marketplace as compared to standard commodity parts. This strategy is to differentiate the company's product and service from competitors that only market commodity parts and to capture more value. The strength and toughness of oak parts should compete favorably with other species. The parts are generally less than 1” thick with the exception of stringers that are 1 3/8” thick. The parts will be used by the company’s customers to construct pallets, containers, crating and dunnage. The parts are stacked and bundled by size and grade.

Table 13. Market Survey Summary

	Dimension	Flooring	Pallets	Residue
# Surveyed	25	38	44	58
# Usable	7	15	10	19
Response Rate	28%	39%	23%	33%
Annual Avg. Lumber Usage (BF)	3,670,000	28,466,667	4,824,000	-
Annual Avg. Bark Usage (tons)	-	-	-	24,416
Annual Avg. Chip Usage (tons)	-	-	-	206,751
Annual Avg. Sawdust Usage (tons)	-	-	-	82,335

The parts are sold in quantities demanded by the customers. The part prices are negotiated with customers depending on the part and order size. The company seeks to achieve a premium above commodity prices but remain competitive with other specialty parts suppliers. The products will be distributed to manufacturers in the eastern U.S. The company will target customers in Virginia, Tennessee, North Carolina, West Virginia, and Kentucky. Distributing products via electronic commerce should be investigated. The promotion efforts will include a brochure, website, trade show attendance, and paid advertising in *Pallet Enterprise* and on the National Wood Pallet and Container Association website.

The marketing strategy for the 3.5 million board feet of lumber produced annually follows. The target market for the lumber is flooring manufacturers and dimension manufacturers along with wholesalers as needed. Furniture frame manufacturers are not targeted because of the decline of domestic furniture manufacturing. In the market survey flooring and dimension manufacturers reported purchasing on average 28.5

million and 3.5 million BF of lumber each year, respectively (Table 13). The price, quality, and service that customers receive will be as good as the competition.

The lumber will be graded in accordance to the National Hardwood Lumber Association's (NHLA) grading rules. The company will produce 1-inch thick lumber that will be sold green, random length, and random width. The lumber could be sorted for width and length according to customer demand. The lumber yield analysis that was conducted at the case study mill indicated that 75% of this lumber would be 2A and 3A, low grade lumber, with the remaining 25% being 1C. The target markets match with the lumber grades that would be produced by the company. The lumber grades used by dimension, flooring, furniture frame, and pallet and container manufacturers as discovered in the market survey are shown in Figure 43.

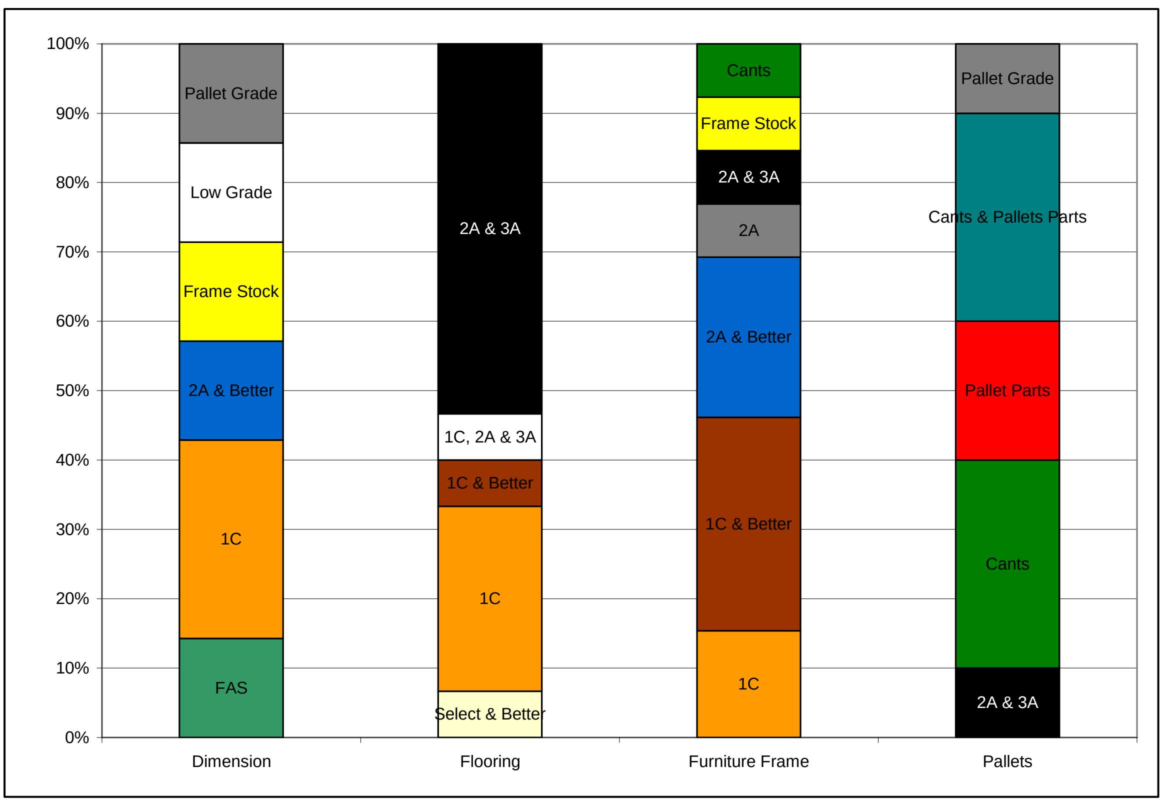

Figure 43. Lumber Grade Usage by Market Segment

The lumber will be priced competitively according to the *Hardwood Market Report* and the *Hardwood Review*. The lumber will be distributed in truckload quantities to customers in Virginia, Tennessee, North Carolina, West Virginia, and Kentucky. The distribution of lumber via the Internet will be investigated. Potential customers in eastern states other than those previously listed will be sought as transportation costs allow. The promotion efforts will include a brochure, website, trade show attendance, and paid advertising in the *Hardwood Market Report*, *Hardwood Review*, *National Hardwood Magazine*, and *Hardwood Lumber Buyer*. The company will be listed and and buy advertisements on the NHLA website.

The wood residues, chips, sawdust, and bark, will be sorted and stored as separate products. The target markets for residues are paper, pulp, fiberboard, and particleboard manufacturers along wood-fired boiler operations, landscapers, and local agricultural users. The wood residue users in the market survey reported purchasing an average of 206,751 tons, 82,335 tons, and 24,416 tons of chips, sawdust and bark annually, respectively (Table 13). The price, quality, and service that our customers receive will be as good as the competition.

The chips will be of high quality for use in pulp, paper and fiberboard manufacturing. The sawdust will be sold as boiler fuel; for the manufacture of particleboard; and to local agricultural users. The bark will be sold as mulch to local consumers and wholesalers. The chips and sawdust will be delivered by the company to the customer. The company will incur the cost of freight and will deliver truckload quantities to customers within 150 - 200 miles. The prices for the chips and sawdust will generally be set by the customer and the bark will be priced by the company depending on quantity purchased. The promotion of wood residues will be limited to the establishment of initial relationships with key customers. This could include site visits to chip and sawdust customers and contacting local mulch users and wholesalers.

Implementation

The marketing plan will be implemented by the marketing manager working in conjunction with the production manager. The marketing manager will directly supervise one salesperson who will spend the majority of his/her time traveling to customers' operations. Open communication from the customers to the salesperson and then to the marketing and production managers will be essential in the successful implementation of the marketing plan. The marketing manager will be responsible for achieving sales goals and modifying the marketing plan as needed. The production and marketing manager will work together to schedule production. The initial marketing budget includes approximately $200,000 per year for marketing expenses. This should be adequate to cover travel expenses for the sales person and advertising.

Projections

The sales projections are shown for each product and month in the first year (Figure 44) and on an annual basis for 30 years. (Figure 45)

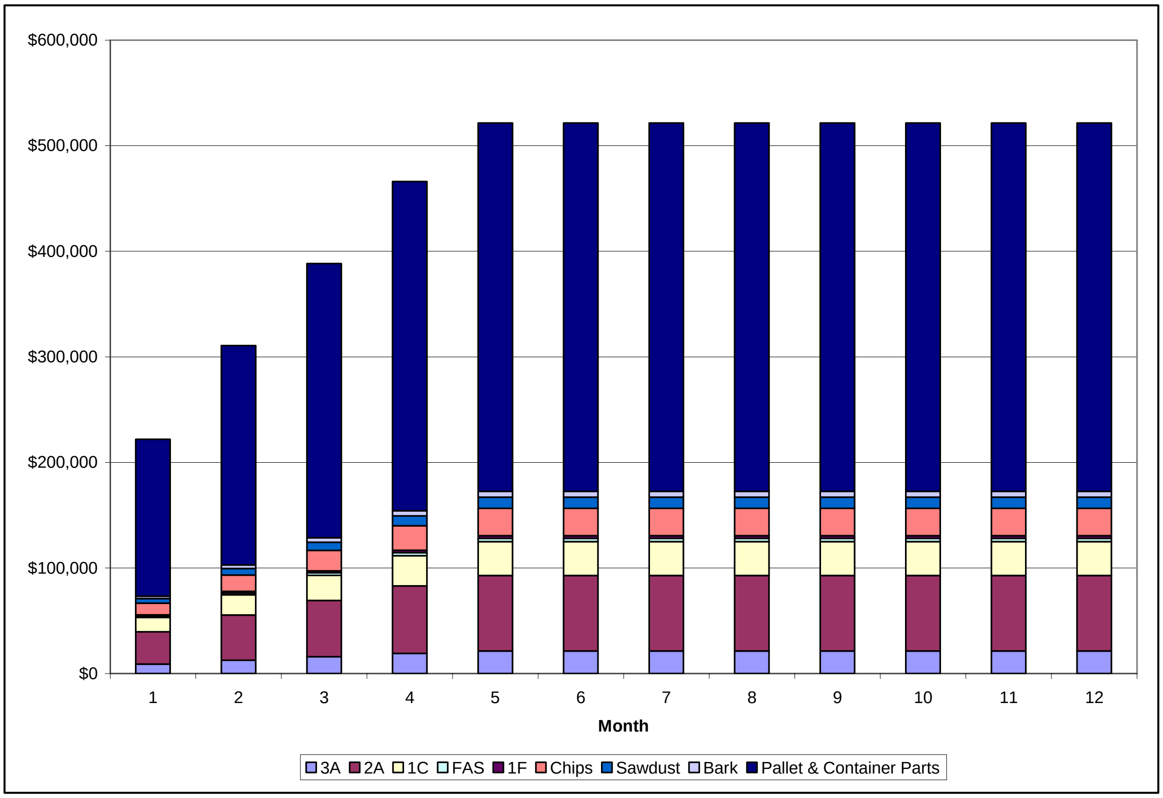

Figure 44. First Year Sales Forecast

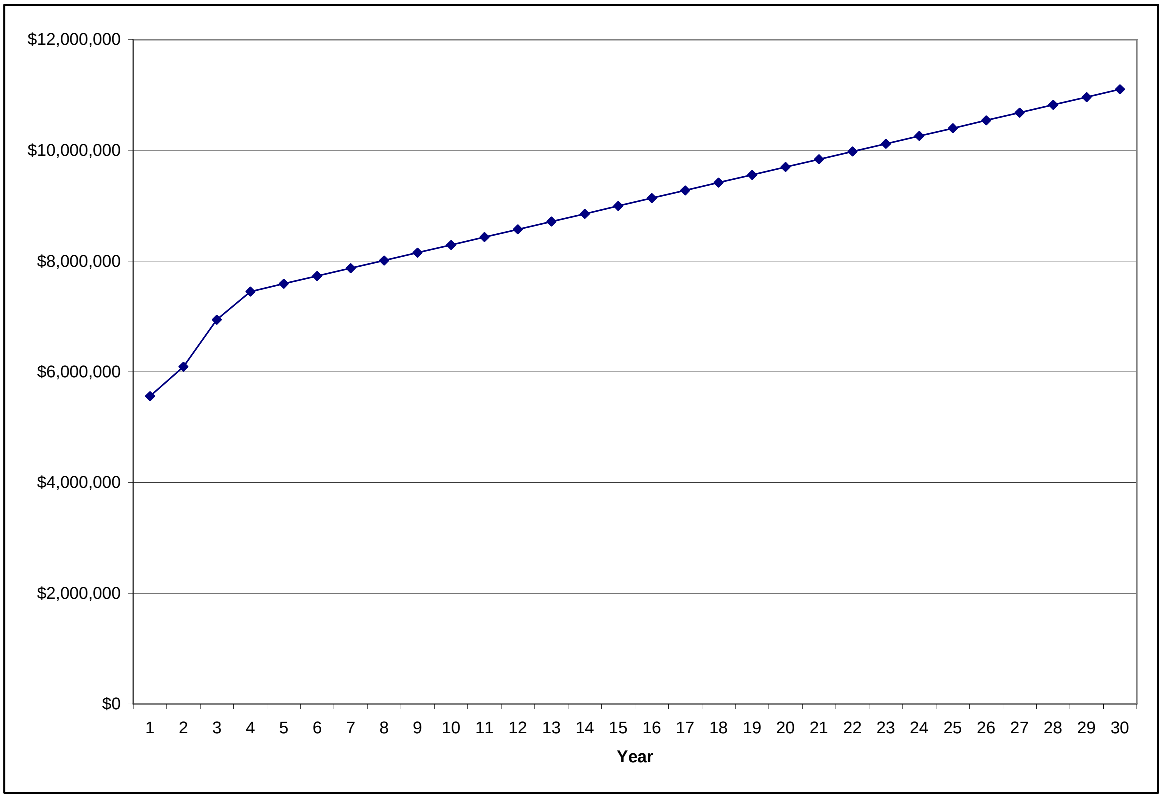

Figure 45. Thirty Year Sales Projection

4.3.5 Operating Plan

<u>Company Location</u>

The company will be located on approximately 20 acres of land. A budget of $800,000 has been allocated to purchase this land, which would include all necessary site preparations such as road building and utility connections. The sawmill and pallet part mill will cost approximately $4.1 million. The exact location of the company within the Southwest Virginia region is flexible but Wythe County appears favorable for numerous reasons. First, the resource analysis indicated (Figure 13 and pg. 31) significant volumes of red oak SDT are available in the surrounding counties. Wythe County is centrally located in the middle of the available red oak SDT resource that is found in Craig, Bland, Pulaski, Smyth, Tazewell and to a lesser extent Wythe and Giles counties (Figure 46). Two major interstates intersect in Wythe County (I-81 and I-77) which would allow good access to a variety of markets. Wythe County is also centrally located to the 22 county Southwest Virginia region as defined in the resource analysis.

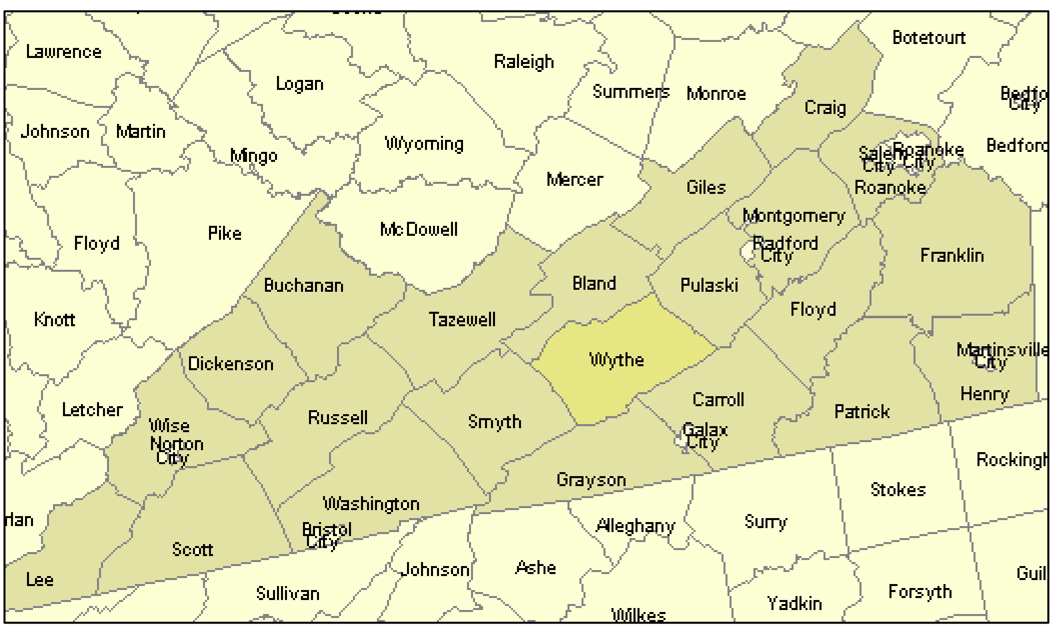

Figure 46. Southwest Virginia Map

Human Resources

The company will employ 26 people. The management positions include a production manager, marketing manager, and office manager. There will be one salesperson and one mill supervisor. The mill will require 9 machine operators. There will be one floater, one maintenance technician, and one saw filer. The two graders will be supported by seven laborers who will stack the lumber and parts. The first year salaries of all employees are shown in Table 14.

Table 14. Position Title & Salary

Position Description	Annual Salary
Production Manager	$50,000
Marketing Manager	$50,000
Office Manager	$30,000
Supervisor	$40,000
Salesperson	$40,000
Scale Operator	$32,000
Log Crane Operator	$32,000
De-barker Operator	$32,000
Scragg Mill Operator	$32,000
Gang Re-saw Operator	$32,000
Edger Operator	$32,000
Trimmer Operator	$32,000
Cross-Cut Operator	$32,000
Lumber Grader	$32,000
Part Grader	$32,000
Fork Lift Operator	$32,000
Maintenance Technician	$32,000
Saw Filer	$32,000
Floater	$32,000
Lumber Stacker	$20,000
Lumber Stacker	$20,000
Lumber Stacker	$20,000
Lumber Stacker	$20,000
Lumber Stacker	$20,000
Part Stacker	$20,000
Part Stacker	$20,000

The operator salaries are better than the Virginia average salary for experienced woodworking machine operators, which is approximately $27,000 per year (VEC, 2006). The stacker salaries are comparable to the Virginia median salary for material movers (VEC, 2006). The average salaries for all employees at the company are equivalent to the average salary in the New River/Mt. Rogers area (VEC, 2006).

The company will provide health insurance and retirement, whose costs are approximately 25% of salary. The two graders will be trained to grade hardwood lumber and parts by the NHLA lumber grading school. The machinery manufacturers will train employees in the operation of their machines.

Raw Materials

The company will purchase it's logs at the gate, meaning that the company will not purchase stumpage or land for harvesting. The company will pay $35/ton for red oak small diameter logs. The logs will be weight scaled and this will encourage loggers to deliver green logs. The freight is included in the cost of the logs. The goal is to keep one month's supply of logs. A first in, first out inventory system will be used for the logs.

The loggers will be paid weekly. Factors that could negatively affect log supply include a general decline in the number of loggers and some of the SDT is owned by the United States Forest Service, which usually does not harvest as much timber as the private sector does. The additional cants that will need to be purchased to supplement the in-house production will be purchased for market prices (e.g.: $320/MBF). Cant suppliers will be paid monthly. The incoming cants will be received and inspected by the mill supervisor.

Production

The mill will experience start up delays just like any other manufacturer. The company has anticipated this and in turn planned and set goals accordingly. The capacity utilization will increase gradually over the first 4 months. The first month's capacity goal is 40%; 56% in the second month; 70% in the third month; 84% in the fourth month; and 94% in the fifth month. The goal for the rest of the year is to achieve 94% capacity utilization each month and the first year's goal is to average 83%. The work schedule consists of four ten hour shifts starting at 6am and ending at 5pm. The employees will get two 15-minute breaks and a half hour lunch break. The company will plan to shut down two weeks each year for holidays.

4.3.6 Financial Plan

The financial plan includes the capital requirements and sources, *pro forma* financial statements, and an economic analysis. The capital requirements are based upon the initial investment as outlined in Table 15. The land and site preparation costs, including water, sewer and road, were the product of $40,000/acre and 20 acres (Loftus, 2006). The initial costs of the buildings, machinery and equipment for both the sawmill and pallet part mill were calculated by appreciating the initial costs (supplied by the participating company) to 2005 dollars using a 4% discount rate. The working capital estimate was derived from the need to disburse payment for goods and services received during the first four months of the first year when sales would be considerably below normal.

Table 15. Initial Investment Costs

Sawmill Only	
Description	**Initial Cost**
Land	$800,000
Buildings	$526,777
Machinery & Equipment	$3,305,796
Working Capital	$1,087,614
Office Equipment	$19,413
Total	**$5,739,600**
Pallet Part Mill Only	
Description	**Initial Cost**
Buildings	$14,210
Machinery & Equipment	$296,222
Working Capital	$719,665
Total	**$1,030,097**
Total Sawmill & PP Operation	**$6,769,698**

The initial financing is 50% debt and 50% equity. This debt to equity ratio is derived from the wood product industry average in 2002 (IRS, 2006). The debt repayment would begin in year one and the equity repayment would begin in year two. The sawmill and pallet part mill is expected to operate for 30 years.

The *pro forma* financial statements (Appendix C) are based on the sales forecast, which in turn is dependent upon the capacity utilization. The financial statements, including the cash flow budget, income statement and balance sheet, are shown for the first year and for 30 years. The cash flow budget is shown monthly for the first year. The Modified Accelerated Cost Recovery System (MACRS) is used as the depreciation method (IRS, 2005). The *pro forma* financial statements assume that the company will not pay any federal or state income tax. However, the Virginia forest products tax is incurred by the company. The revenues and costs are assumed to be subject to inflation each year by a rate of 2%. This was based on the industry average from 1980 to 2005. (BLS, 2006). The economic analysis was based on the actual net income from the income statement (Figure 47).

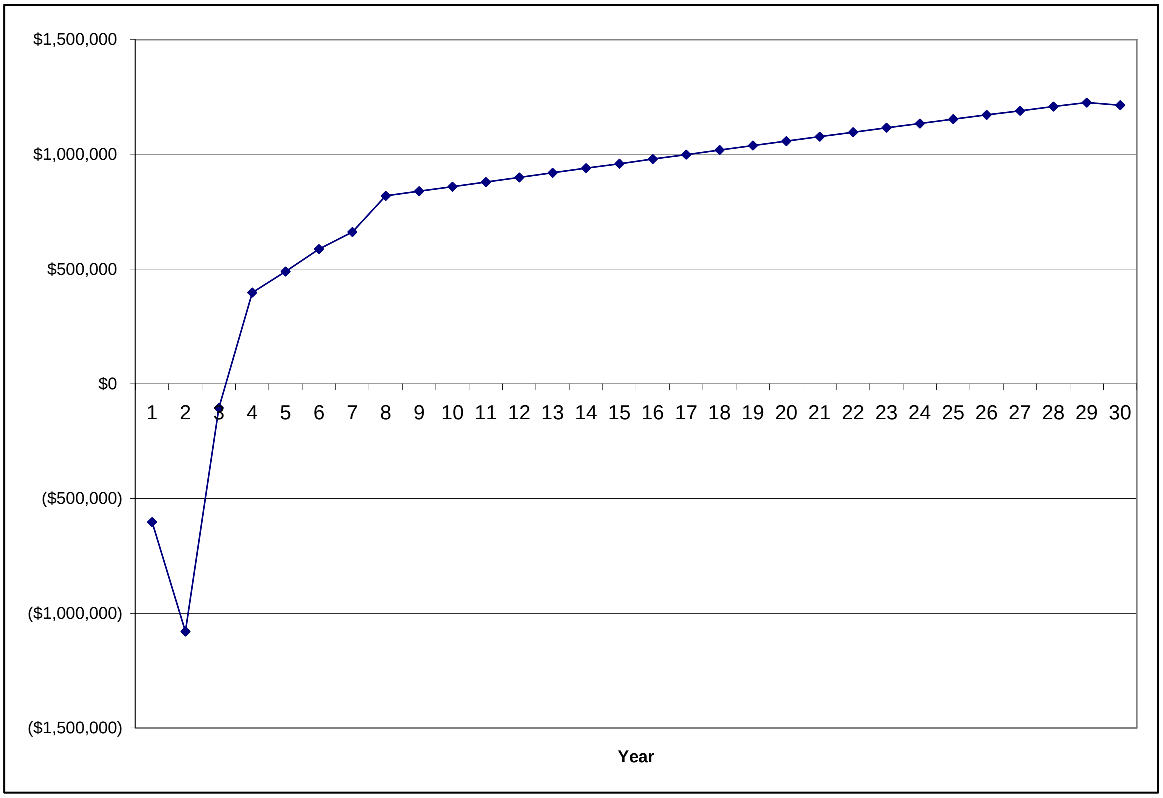

Figure 47. Net Income of Hypothetical Company

The economic analysis used net present value and internal rate of return as the financial metrics (Figure 48). The discount rate used to calculate NPV was 10%. This discount rate is similar to long term industry averages reported by Hogaboam and Shook (2004). The discount rate reflects the cost of capital, whether it is sourced from creditors (debt) or investors (equity). Typically, investors require a greater return as compared to creditors.

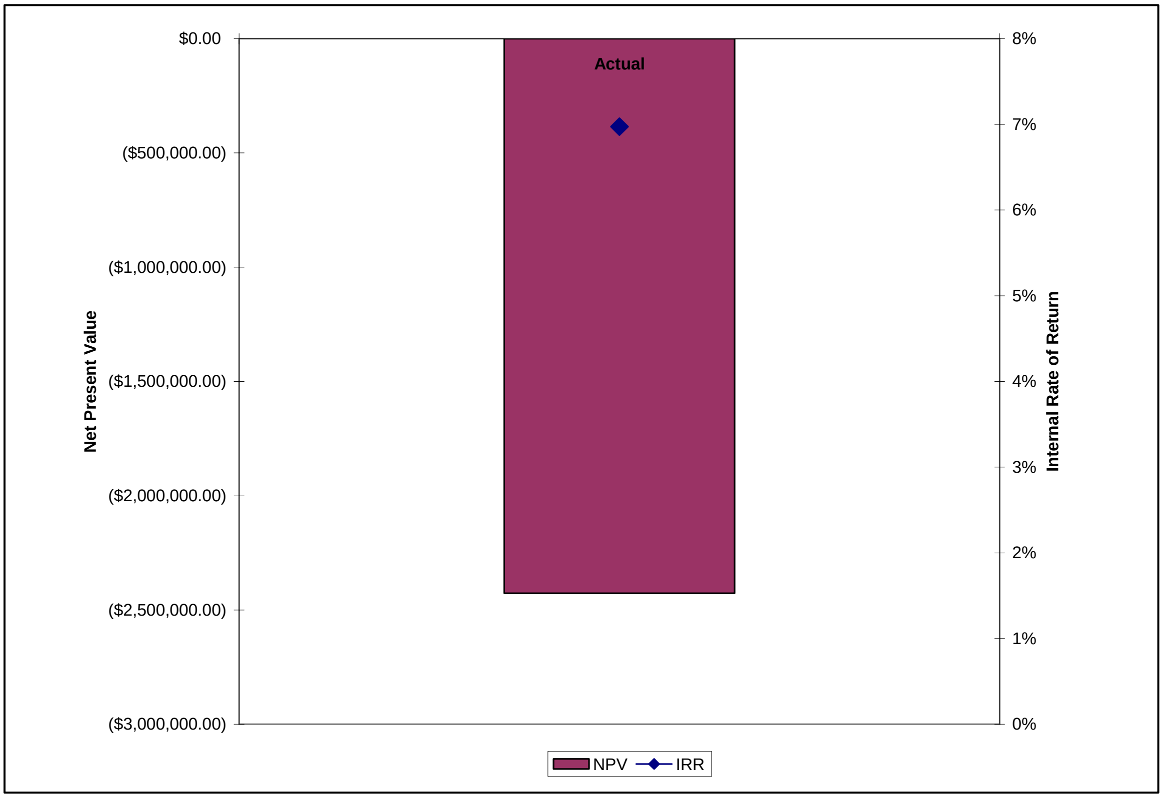

Figure 48. NPV & IRR of Hypothetical Company

The net present value has a negative value of over $2 million and the internal rate of return is approximately 7%, which is below the 10% discount rate used. The two financial metrics indicate that the business is not feasible given these assumptions and cash flow. A discussion of the caveats inherent in these two metrics is contained in the discussion section.

4.3.7 Discussion

The initial economic analysis performed as part of this research project indicated a positive NPV and an IRR of approximately 11% at $35/ton log cost (Figure 49). The initial economic analysis assumed a constant (straight-line) depreciation of $155,533 and a 100% utilization and sales rate. The economic analysis of Southwest Custom Hardwoods' net income produced a negative NPV and an IRR of 7%. This additional analysis of the actual operation was based on net income calculated with the MACRS depreciation method and variable utilization and sales rates.

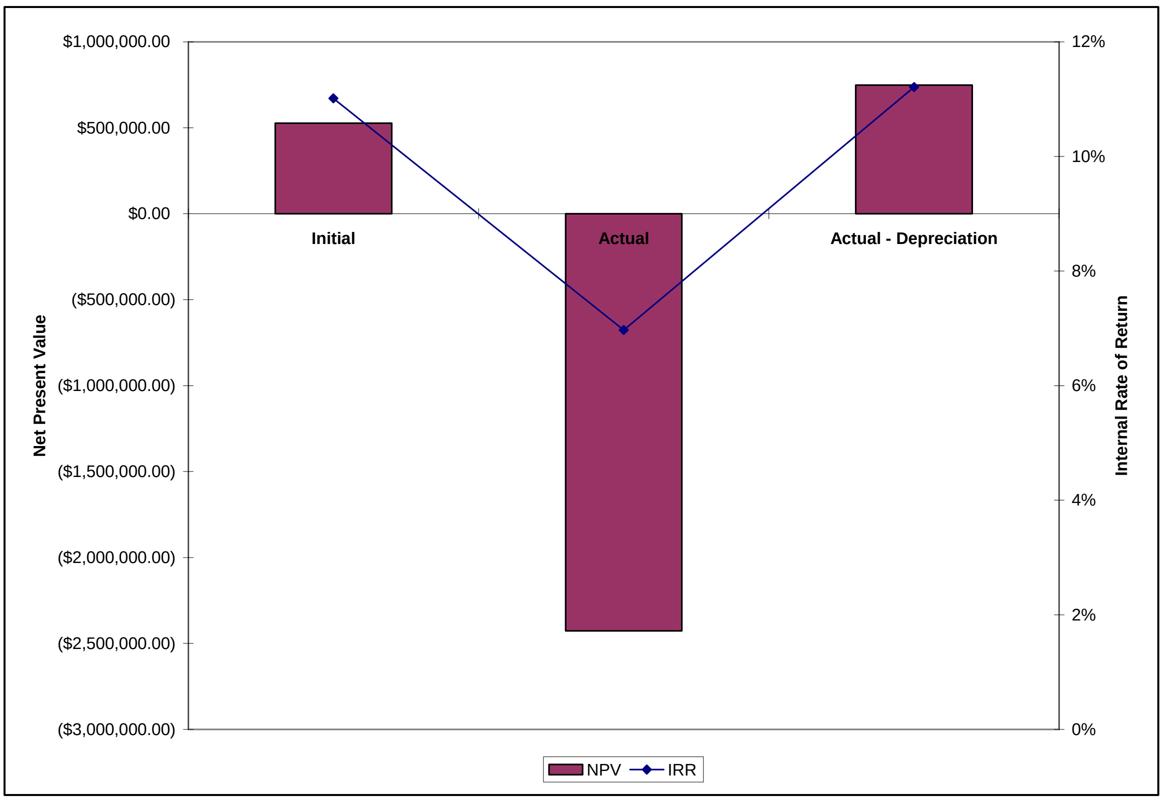

Figure 49. Initial Actual and Depreciation Adjusted NPV & IRR

However, since depreciation is a non-cash expense, the value of depreciation was subtracted from the net income of the actual operation. The resultant NPV was positive, IRR was 11%, and both measures were greater than the initial NPV and IRR values (Figure 49). This indicates that the project is economically feasible given the assumptions and the 10% discount rate. The depreciation expense does not affect the financial attractiveness of the project because this expense is actually not incurred by the company. It is utilized to calculate income taxes to be paid by the company. (Lang and Merino, 1993).

4.3.8 Limitations

This business plan is limited in that it is temporal and contextual. The plan is based on results from resource, product yield and economic analyses. These analyses focused on red oak SDT made into 1-inch thick lumber and 3" wide container parts. Certainly, alternative solid wood products could be made from red oak and well as other species of SDT that are available in the Southwest Virginia region. The economics and preferences of the marketplace are dynamic and should be carefully re-assessed before initiating any venture.

4.4.0 Summary

The business model of utilizing red oak SDT logs and making lumber, pallet and container parts, and residues is economically feasible with certain caveats. First, the market environment is dynamic and solid wood product utilization has declined due to substitutes. Second, the red oak lumber and 3" container parts produced in the associated yield analysis are only one of many possible product configurations. The latter have not been modeled because that would require multiple SDT yield analyses and/or computer simulations; both of which are recommended for future research. Third, the ability to weight scale low value SDT logs and the machinery configuration should have cost advantages compared to grade sawmills. Finally, Southwest Custom Hardwoods is economic feasible because the final NPV is positive and the final IRR is 11%.

4.5.0 Literature Cited

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5.0 Conclusions, Limitations & Recommendations

5.1.0 Conclusions

The resource analysis indicated an ample supply of red oak SDT available in Southwest Virginia. Craig, Bland, Pulaski, Smyth, Tazewell and to a lesser extent Wythe and Giles counties have the most red oak SDT in the region. However, the USDA Forest Service owns the majority of the red oak SDT volume in Craig, Bland, Wythe, and Giles counties.

The yield analysis used 233 red oak SDT logs, which were manufactured into lumber, container parts and wood residues. The total solid wood and residue yield included lumber and pallet parts (35%), chips (29%), sawdust (26%), and bark (10%). The majority of solid wood produced was in the form of 3 inch thick cants, whose proportional volume decreased as log diameter increased. Seventy-four percent of the total lumber volume produced was 2A and 3A and twenty four percent was 1 common. The yield of container parts ranged from 63% to 66%.

The economic analysis utilized break even analysis and net present value and internal rate of return analysis to determine the economic feasibility of utilizing red oak SDT. The break even analysis compared revenue-to-cost ratios for a number of different scenarios. The actual-yield scenario results obscured any relationship between profitability and log diameter at the sawmill-only and the sawmill and pallet part mill processing level. The average-yield scenario results indicated that larger diameter logs would be more profitable than smaller logs due to lower operating costs and yield of more valuable products. The sawmill and pallet part mill processing level was found to be more profitable as indicated by greater revenue-to-cost ratios. All log diameters were profitable under the sawmill and pallet part mill actual yield scenario, therefore, the net present value and internal rate of return analyses assumed the utilization of all log diameters.

The sawmill-only processing level scenario is not economically feasible given the specified conditions and assumptions. The sawmill and pallet part mill, actual yield scenario at $35/ton delivered log cost was found to be economically feasible. This scenario forms the basis for the development of the business plan.

The business model of utilizing red oak SDT logs and making lumber, pallet and container parts, and residues was found to be economically feasible with certain caveats. First, the market environment is dynamic and solid wood product utilization has declined due to substitutes. Second, the red oak lumber and 3 inch container parts produced in the associated yield analysis are only one of many possible product configurations. The latter have not been modeled because that would require multiple SDT yield analyses and/or computer simulations; both of which are recommended for future research. Third, the ability to weight scale low value SDT logs and the machinery configuration should have cost advantages compared to grade sawmills. Finally, Southwest Custom Hardwoods, the hypothetical company is economic feasible because the final NPV is positive and the final IRR is 11%.

5.2.0 Limitations

The results should be interpreted within the context of this research. The timber volume, market price, and cost data used in this research are temporal. The yield analysis used only one species, one mill product configuration (1-inch thick lumber and 3" container parts), and one sample. The yield analysis and subsequent economic analyses are based on old sawing technology and newer technology may achieve greater yield and therefore improve the economic analysis. The cost information from the participating mill was linearly adjusted based on a lower capacity and these costs may not accurately represent the industry average. The market and economic conditions are dynamic and marketing and production strategies may need to be revised dependent upon the magnitude of changes. The

5.3.0 Recommendations

Future yield studies should measure taper and large end diameter of logs to achieve greater accuracy in estimations of cubic foot volume. Future yield studies should weigh logs so that the yield of residues and solid wood products can be directly compared. Furthermore, the anticipated utilization of small diameter logs will limit the efficiency of volumetric log scaling, whether based on cubic or board foot rules.

Future research into the utilization of hardwood SDT should include yield studies of other species that are abundant in the Southwest Virginia region and other hardwood forest regions. The investigation of other product configurations from SDT is also warranted.

Appendices

Appendix A. Lumber Market Questionnaire

Lumber Market Survey

ID#:______________Company:____

Contact:______________________Date:___________________Result:____________

1. What lumber grades do you use? 3A 2A 1C 1F FAS
   Other:

2. What are your annual purchase volumes?

3. Has your use of lumber INCREASED, DECREASED, OR REMAINED THE SAME?

4. Do you expect your use of lumber to INCREASE or DECREASE in the future?

5. Are you satisfied with your current suppliers? YES NO

6. If no, what supply problems are you having?

Appendix B. Residue Market Questionnaire

Residue Market Survey

ID#:______________Company:____

Contact:______________________Date:___________________Result:____________

1. What are your annual purchase volumes of Bark?
   Chips?
   Sawdust?

2. Has your use of
   Bark INCREASED, DECREASED, OR REMAINED THE SAME?
   Chips INCREASED, DECREASED, OR REMAINED THE SAME?
   Sawdust INCREASED, DECREASED, OR REMAINED THE SAME?

3. Do you expect your use of bark, chips, and sawdust to INCREASE or DECREASE in the future?

4. What is the farthest distance that you receive bark, chips and sawdust from?

5. Are you satisfied with your current suppliers? YES NO

6. If no, what supply problems are you having?

Appendix C. *Pro Forma* Financial Statements

Table 16. Cash Flow Budget for First Year

	1st Month	*2nd Month*	*3rd Month*	*4th Month*	*5th Month*	*6th Month*	*7th Month*	*8th Month*	*9th Month*	*10th Month*	*11 Month*	*12th Month*	*Total*
Beginning Cash Balance		$570,489	$1,149,315	$1,735,437	$1,726,427	$1,722,629	$1,718,830	$1,715,032	$1,711,234	$1,707,435	$1,703,637	$1,699,839	
Cash Inflows (Income):													
Working Capital	$602,427	$602,427	$602,427										$1,807,280
Sales & Receipts	$221,904	$310,666	$388,332	$465,999	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$5,558,697
Total Cash Inflows	$824,331	$913,092	$990,759	$465,999	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$521,475	$7,365,976
Available Cash Balance	$824,331	$1,483,581	$2,140,074	$2,201,435	$2,247,902	$2,244,103	$2,240,305	$2,236,507	$2,232,708	$2,228,910	$2,225,111	$2,221,313	
Cash Outflows (Expenses):													
Administration	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$1,114	$13,369
Direct Labor	$31,556	$44,179	$55,223	$66,268	$74,157	$74,157	$74,157	$74,157	$74,157	$74,157	$74,157	$74,157	$790,480
Equipment Rental	$4,829	$6,760	$8,450	$10,140	$11,347	$11,347	$11,347	$11,347	$11,347	$11,347	$11,347	$11,347	$120,954
Freight	$17,557	$24,579	$30,724	$36,869	$41,258	$41,258	$41,258	$41,258	$41,258	$41,258	$41,258	$41,258	$439,797
Indirect Expenses	$12,297	$17,215	$21,519	$25,823	$28,897	$28,897	$28,897	$28,897	$28,897	$28,897	$28,897	$28,897	$308,029
Indirect Labor	$6,472	$9,060	$11,325	$13,590	$15,208	$15,208	$15,208	$15,208	$15,208	$15,208	$15,208	$15,208	$162,113
Insurance	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$5,144	$61,728
Interest	$28,207	$28,195	$28,182	$28,169	$28,157	$28,144	$28,131	$28,118	$28,104	$28,091	$28,078	$28,064	$337,638
Log & Cant Purchases	$115,556	$161,778	$202,223	$242,668	$271,557	$271,557	$271,557	$271,557	$271,557	$271,557	$271,557	$271,557	$2,894,679
Maintenance	$9,354	$13,095	$16,369	$19,643	$21,981	$21,981	$21,981	$21,981	$21,981	$21,981	$21,981	$21,981	$234,308
Marketing	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$16,819	$201,833
Operating Supplies	$1,754	$2,456	$3,070	$3,684	$4,122	$4,122	$4,122	$4,122	$4,122	$4,122	$4,122	$4,122	$43,942
Payroll Taxes	$1,610	$2,255	$2,818	$3,382	$3,784	$3,784	$3,784	$3,784	$3,784	$3,784	$3,784	$3,784	$40,341
Taxes	$76	$107	$133	$160	$179	$179	$179	$179	$179	$179	$179	$179	$1,910
Subtotal	$252,345	$332,756	$403,114	$473,473	$523,725	$523,712	$523,699	$523,686	$523,673	$523,659	$523,646	$523,632	$5,651,121
Other Cash Out Flows:													
Loan Principal	$1,497	$1,510	$1,522	$1,535	$1,548	$1,561	$1,574	$1,587	$1,600	$1,614	$1,627	$1,641	$18,816
Owner's Draw													
Subtotal	$1,497	$1,510	$1,522	$1,535	$1,548	$1,561	$1,574	$1,587	$1,600	$1,614	$1,627	$1,641	$18,816
Total Cash Outflows	$253,842	$334,266	$404,637	$475,008	$525,273	$525,273	$525,273	$525,273	$525,273	$525,273	$525,273	$525,273	$5,669,936
Ending Cash Balance	$570,489	$1,149,315	$1,735,437	$1,726,427	$1,722,629	$1,718,830	$1,715,032	$1,711,234	$1,707,435	$1,703,637	$1,699,839	$1,696,040	

Table 17. Cash Flow Budget for Years 1 - 10

	Yr1	*Yr2*	*Yr3*	*Yr4*	*Yr5*	*Yr6*	*Yr7*	*Yr8*	*Yr9*	*Yr10*
Beginning Cash Balance		$1,696,040	$1,294,188	$1,620,481	$2,330,369	$3,058,200	$3,803,694	$4,566,545	$5,346,413	$6,142,924
Cash Inflows (Income):										
Sales & Receipts	$5,558,697	$6,092,376	$6,942,639	$7,448,580	$7,589,119	$7,729,658	$7,870,198	$8,010,737	$8,151,276	$8,291,815
Working Capital	$1,807,280									
Total Cash Inflows	$7,365,976	$6,092,376	$6,942,639	$7,448,580	$7,589,119	$7,729,658	$7,870,198	$8,010,737	$8,151,276	$8,291,815
Available Cash Balance	$7,365,976	$7,788,416	$8,236,826	$9,069,060	$9,919,488	$10,787,858	$11,673,892	$12,577,282	$13,497,689	$14,434,739
Cash Outflows (Expenses):										
Administration	$13,369	$13,636	$13,904	$14,171	$14,438	$14,706	$14,973	$15,240	$15,508	$15,775
Direct Labor	$790,480	$917,336	$935,322	$953,309	$971,296	$989,283	$1,007,270	$1,025,257	$1,043,244	$1,061,231
Equipment Rental	$120,954	$140,365	$143,117	$145,869	$148,621	$151,374	$154,126	$156,878	$159,630	$162,383
Freight	$439,797	$510,376	$520,383	$530,390	$540,398	$550,405	$560,413	$570,420	$580,427	$590,435
Indirect Expenses	$308,029	$357,462	$364,471	$371,480	$378,489	$385,498	$392,507	$399,516	$406,525	$413,534
Indirect Labor	$162,113	$188,128	$191,817	$195,506	$199,195	$202,884	$206,572	$210,261	$213,950	$217,639
Insurance	$61,728	$62,962	$64,197	$65,431	$66,666	$67,900	$69,135	$70,369	$71,604	$72,838
Interest	$337,638	$337,638	$335,668	$333,491	$331,087	$328,430	$325,496	$322,254	$318,673	$314,717
Log & Cant Purchases	$2,894,679	$3,359,214	$3,425,081	$3,490,948	$3,556,815	$3,622,682	$3,688,549	$3,754,416	$3,820,283	$3,886,149
Maintenance & Repairs	$234,308	$271,910	$277,241	$282,573	$287,904	$293,236	$298,568	$303,899	$309,231	$314,562
Marketing	$201,833	$195,577	$199,411	$203,246	$207,081	$210,916	$214,751	$218,586	$222,420	$226,255
Operating Supplies	$43,942	$50,994	$51,994	$52,993	$53,993	$54,993	$55,993	$56,993	$57,993	$58,993
Payroll Taxes	$40,341	$46,815	$47,733	$48,651	$49,569	$50,487	$51,405	$52,322	$53,240	$54,158
Taxes	$1,910	$2,216	$2,260	$2,303	$2,347	$2,390	$2,433	$2,477	$2,520	$2,564
Subtotal	$5,651,121	$6,454,627	$6,572,598	$6,690,362	$6,807,899	$6,925,183	$7,042,190	$7,158,889	$7,275,249	$7,391,234
Other Cash Out Flows:										
Loan Principal	$18,816	$20,786	$22,962	$25,367	$28,023	$30,958	$34,199	$37,780	$41,736	$46,107
Owner's Draw	$0	$18,816	$20,786	$22,962	$25,367	$28,023	$30,958	$34,199	$37,780	$41,736
Subtotal	$18,816	$39,602	$43,748	$48,329	$53,390	$58,981	$65,157	$71,980	$79,517	$87,843
Total Cash Outflows	$5,669,936	$6,494,228	$6,616,346	$6,738,691	$6,861,289	$6,984,164	$7,107,347	$7,230,869	$7,354,766	$7,479,077
Ending Cash Balance	$1,696,040	$1,294,188	$1,620,481	$2,330,369	$3,058,200	$3,803,694	$4,566,545	$5,346,413	$6,142,924	$6,955,662

Table 18. Cash Flow Budget for Years 11 - 20

	Yr11	*Yr12*	*Yr13*	*Yr14*	*Yr15*	*Yr16*	*Yr17*	*Yr18*	*Yr19*	*Yr20*
Beginning Cash Balance	$6,955,662	$7,784,171	$8,627,944	$9,486,424	$10,358,993	$11,244,969	$12,143,601	$13,054,055	$13,975,414	$14,906,661
Cash Inflows (Income):										
Sales & Receipts	$8,432,355	$8,572,894	$8,713,433	$8,853,972	$8,994,512	$9,135,051	$9,275,590	$9,416,129	$9,556,669	$9,697,208
Working Capital										
Total Cash Inflows	$8,432,355	$8,572,894	$8,713,433	$8,853,972	$8,994,512	$9,135,051	$9,275,590	$9,416,129	$9,556,669	$9,697,208
Available Cash Balance	$15,388,017	$16,357,064	$17,341,377	$18,340,396	$19,353,504	$20,380,020	$21,419,191	$22,470,184	$23,532,082	$24,603,869
Cash Outflows (Expenses):										
Administration	$16,043	$16,310	$16,577	$16,845	$17,112	$17,379	$17,647	$17,914	$18,182	$18,449
Direct Labor	$1,079,218	$1,097,205	$1,115,192	$1,133,179	$1,151,166	$1,169,153	$1,187,140	$1,205,127	$1,223,114	$1,241,101
Equipment Rental	$165,135	$167,887	$170,639	$173,392	$176,144	$178,896	$181,648	$184,401	$187,153	$189,905
Freight	$600,442	$610,449	$620,457	$630,464	$640,472	$650,479	$660,486	$670,494	$680,501	$690,508
Indirect Expenses	$420,543	$427,552	$434,561	$441,570	$448,579	$455,588	$462,597	$469,606	$476,615	$483,624
Indirect Labor	$221,327	$225,016	$228,705	$232,394	$236,083	$239,771	$243,460	$247,149	$250,838	$254,527
Insurance	$74,073	$75,308	$76,542	$77,777	$79,011	$80,246	$81,480	$82,715	$83,949	$85,184
Interest	$310,347	$305,519	$300,185	$294,293	$287,784	$280,594	$272,650	$263,875	$254,181	$243,471
Log & Cant Purchases	$3,952,016	$4,017,883	$4,083,750	$4,149,617	$4,215,484	$4,281,351	$4,347,218	$4,413,085	$4,478,952	$4,544,819
Maintenance & Repairs	$319,894	$325,225	$330,557	$335,889	$341,220	$346,552	$351,883	$357,215	$362,546	$367,878
Marketing	$230,090	$233,925	$237,760	$241,595	$245,429	$249,264	$253,099	$256,934	$260,769	$264,604
Operating Supplies	$59,993	$60,992	$61,992	$62,992	$63,992	$64,992	$65,992	$66,992	$67,992	$68,991
Payroll Taxes	$55,076	$55,994	$56,912	$57,830	$58,748	$59,666	$60,584	$61,502	$62,420	$63,338
Taxes	$2,607	$2,651	$2,694	$2,738	$2,781	$2,825	$2,868	$2,911	$2,955	$2,998
Subtotal	$7,506,804	$7,621,917	$7,736,525	$7,850,574	$7,964,006	$8,076,756	$8,188,754	$8,299,919	$8,410,166	$8,519,398
Other Cash Out Flows:										
Loan Principal	$50,935	$56,268	$62,160	$68,669	$75,860	$83,803	$92,579	$102,273	$112,982	$124,813
Owner's Draw	$46,107	$50,935	$56,268	$62,160	$68,669	$75,860	$83,803	$92,579	$102,273	$112,982
Subtotal	$97,042	$107,203	$118,429	$130,830	$144,529	$159,663	$176,382	$194,852	$215,255	$237,795
Total Cash Outflows	$7,603,846	$7,729,120	$7,854,953	$7,981,403	$8,108,535	$8,236,419	$8,365,136	$8,494,771	$8,625,421	$8,757,193
Ending Cash Balance	$7,784,171	$8,627,944	$9,486,424	$10,358,993	$11,244,969	$12,143,601	$13,054,055	$13,975,414	$14,906,661	$15,846,676

Table 19. Cash Flow Budget for Years 21 - 30

	Yr21	*Yr22*	*Yr23*	*Yr24*	*Yr25*	*Yr26*	*Yr27*	*Yr28*	*Yr29*	*Yr30*
Beginning Cash Balance	$15,846,676	$16,794,220	$17,747,924	$18,706,276	$19,667,607	$20,630,070	$21,591,629	$22,550,030	$23,502,787	$24,447,152
Cash Inflows (Income):										
Sales & Receipts	$9,837,747	$9,978,286	$10,118,825	$10,259,365	$10,399,904	$10,540,443	$10,680,982	$10,821,522	$10,962,061	$11,102,600
Working Capital										
Total Cash Inflows	$9,837,747	$9,978,286	$10,118,825	$10,259,365	$10,399,904	$10,540,443	$10,680,982	$10,821,522	$10,962,061	$11,102,600
Available Cash Balance	$25,684,423	$26,772,506	$27,866,749	$28,965,641	$30,067,511	$31,170,513	$32,272,611	$33,371,552	$34,464,848	$35,549,753
Cash Outflows (Expenses):										
Administration	$18,716	$18,984	$19,251	$19,518	$19,786	$20,053	$20,321	$20,588	$20,855	$21,123
Direct Labor	$1,259,088	$1,277,075	$1,295,062	$1,313,049	$1,331,036	$1,349,023	$1,367,010	$1,384,997	$1,402,984	$1,420,971
Equipment Rental	$192,657	$195,410	$198,162	$200,914	$203,666	$206,419	$209,171	$211,923	$214,675	$217,428
Freight	$700,516	$710,523	$720,530	$730,538	$740,545	$750,553	$760,560	$770,567	$780,575	$790,582
Indirect Expenses	$490,634	$497,643	$504,652	$511,661	$518,670	$525,679	$532,688	$539,697	$546,706	$553,715
Indirect Labor	$258,215	$261,904	$265,593	$269,282	$272,971	$276,659	$280,348	$284,037	$287,726	$291,415
Insurance	$86,419	$87,653	$88,888	$90,122	$91,357	$92,591	$93,826	$95,060	$96,295	$97,529
Interest	$231,641	$218,571	$204,133	$188,183	$170,563	$151,098	$129,594	$105,839	$79,597	$50,606
Log & Cant Purchases	$4,610,686	$4,676,553	$4,742,420	$4,808,287	$4,874,154	$4,940,021	$5,005,887	$5,071,754	$5,137,621	$5,203,488
Maintenance & Repairs	$373,210	$378,541	$383,873	$389,204	$394,536	$399,867	$405,199	$410,530	$415,862	$421,194
Marketing	$268,438	$272,273	$276,108	$279,943	$283,778	$287,613	$291,447	$295,282	$299,117	$302,952
Operating Supplies	$69,991	$70,991	$71,991	$72,991	$73,991	$74,991	$75,991	$76,990	$77,990	$78,990
Payroll Taxes	$64,256	$65,174	$66,092	$67,009	$67,927	$68,845	$69,763	$70,681	$71,599	$72,517
Taxes	$3,042	$3,085	$3,129	$3,172	$3,216	$3,259	$3,303	$3,346	$3,389	$3,433
Subtotal	$8,627,508	$8,734,379	$8,839,882	$8,943,873	$9,046,194	$9,146,670	$9,245,107	$9,341,293	$9,434,991	$9,525,942
Other Cash Out Flows:										
Loan Principal	$137,882	$152,321	$168,271	$185,891	$205,356	$226,859	$250,614	$276,857	$305,848	$367,333
Owner's Draw	$124,813	$137,882	$152,321	$168,271	$185,891	$205,356	$226,859	$250,614	$276,857	$305,848
Subtotal	$262,695	$290,203	$320,591	$354,161	$391,246	$432,215	$477,474	$527,471	$582,704	$673,180
Total Cash Outflows	$8,890,203	$9,024,582	$9,160,473	$9,298,034	$9,437,440	$9,578,885	$9,722,581	$9,868,764	$10,017,696	$10,199,122
Ending Cash Balance	$16,794,220	$17,747,924	$18,706,276	$19,667,607	$20,630,070	$21,591,629	$22,550,030	$23,502,787	$24,447,152	$25,350,630

Table 20. First Year Income Statement

Revenue:			
	Gross Sales		$5,558,697
	Less: Sales Returns and Allowances		$0
	Net Sales		$5,558,697
Cost of Goods Sold:			
	Beginning Inventory	$0	
	Add: Log & Cant Purchases	$2,894,679	
	Freight	$439,797	
	Direct Labor	$790,480	
	Indirect Expenses	$308,029	
		$4,432,986	
	Less: Ending Inventory	$555,870	
	Cost of Goods Sold		$3,877,116
	Gross Profit (Loss)		$1,681,581
Expenses:			
	Administration	$13,369	
	Debt Payment	$18,816	
	Depreciation	$1,047,410	
	Equipment Rental	$120,954	
	Indirect Labor	$162,113	
	Insurance	$61,728	
	Interest	$337,638	
	Maintenance & Repairs	$234,308	
	Marketing	$201,833	
	Operating Supplies	$43,942	
	Payroll Taxes	$40,341	
	Taxes	$1,910	
	Total Expenses		$2,284,361
	Net Operating Income		($602,780)
Other Income:			
	Total Other Income		$0
Net Income (Loss)			($602,780)

Table 21. Income Statement for Years 1 - 10

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10
Revenue:										
Gross Sales	$5,558,697	$6,092,376	$6,942,639	$7,448,580	$7,589,119	$7,729,658	$7,870,198	$8,010,737	$8,151,276	$8,291,815
Less: Sales Returns	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Sales	$5,558,697	$6,092,376	$6,942,639	$7,448,580	$7,589,119	$7,729,658	$7,870,198	$8,010,737	$8,151,276	$8,291,815
Cost of Goods Sold:										
Beginning Inventory	$0	$555,870	$609,238	$694,264	$744,858	$758,912	$772,966	$787,020	$801,074	$815,128
Add: Log & Cant Purchases	$2,894,679	$3,359,214	$3,425,081	$3,490,948	$3,556,815	$3,622,682	$3,688,549	$3,754,416	$3,820,283	$3,886,149
Freight	$439,797	$510,376	$520,383	$530,390	$540,398	$550,405	$560,413	$570,420	$580,427	$590,435
Direct Labor	$790,480	$917,336	$935,322	$953,309	$971,296	$989,283	$1,007,270	$1,025,257	$1,043,244	$1,061,231
Indirect Expenses	$308,029	$357,462	$364,471	$371,480	$378,489	$385,498	$392,507	$399,516	$406,525	$413,534
	$4,432,986	$5,700,256	$5,854,495	$6,040,391	$6,191,856	$6,306,780	$6,421,704	$6,536,629	$6,651,553	$6,766,477
Less: Ending Inventory	$555,870	$609,238	$694,264	$744,858	$758,912	$772,966	$787,020	$801,074	$815,128	$829,182
Cost of Goods Sold	$3,877,116	$5,091,019	$5,160,231	$5,295,533	$5,432,944	$5,533,814	$5,634,685	$5,735,555	$5,836,425	$5,937,296
Gross Profit (Loss)	$1,681,581	$1,001,357	$1,782,408	$2,153,047	$2,156,175	$2,195,844	$2,235,513	$2,275,182	$2,314,851	$2,354,520
Expenses:										
Administration	$13,369	$13,636	$13,904	$14,171	$14,438	$14,706	$14,973	$15,240	$15,508	$15,775
Debt Payment	$18,816	$20,786	$22,962	$25,367	$28,023	$30,958	$34,199	$37,780	$41,736	$46,107
Depreciation	$1,047,410	$749,673	$537,443	$386,124	$278,209	$200,630	$145,958	$9,468	$9,468	$9,468
Equipment Rental	$120,954	$140,365	$143,117	$145,869	$148,621	$151,374	$154,126	$156,878	$159,630	$162,383
Indirect Labor	$162,113	$188,128	$191,817	$195,506	$199,195	$202,884	$206,572	$210,261	$213,950	$217,639
Insurance	$61,728	$62,962	$64,197	$65,431	$66,666	$67,900	$69,135	$70,369	$71,604	$72,838
Interest	$337,638	$337,638	$335,668	$333,491	$331,087	$328,430	$325,496	$322,254	$318,673	$314,717
Maintenance & Repairs	$234,308	$271,910	$277,241	$282,573	$287,904	$293,236	$298,568	$303,899	$309,231	$314,562
Marketing	$201,833	$195,577	$199,411	$203,246	$207,081	$210,916	$214,751	$218,586	$222,420	$226,255
Operating Supplies	$43,942	$50,994	$51,994	$52,993	$53,993	$54,993	$55,993	$56,993	$57,993	$58,993
Payroll Taxes	$40,341	$46,815	$47,733	$48,651	$49,569	$50,487	$51,405	$52,322	$53,240	$54,158
Taxes	$1,910	$2,216	$2,260	$2,303	$2,347	$2,390	$2,433	$2,477	$2,520	$2,564
Total Expenses	$2,284,361	$2,080,699	$1,887,746	$1,755,725	$1,667,133	$1,608,903	$1,573,608	$1,456,528	$1,475,974	$1,495,459
Net Operating Income	($602,780)	($1,079,342)	($105,339)	$397,321	$489,042	$586,941	$661,905	$818,654	$838,877	$859,061
Other Income:										
Total Other Income	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income (Loss)	($602,780)	($1,079,342)	($105,339)	$397,321	$489,042	$586,941	$661,905	$818,654	$838,877	$859,061

Table 22. Income Statement for Years 11 - 20

	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20
Revenue:										
Gross Sales	$8,432,355	$8,572,894	$8,713,433	$8,853,972	$8,994,512	$9,135,051	$9,275,590	$9,416,129	$9,556,669	$9,697,208
Less: Sales Returns	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Sales	$8,432,355	$8,572,894	$8,713,433	$8,853,972	$8,994,512	$9,135,051	$9,275,590	$9,416,129	$9,556,669	$9,697,208
Cost of Goods Sold:										
Beginning Inventory	$829,182	$843,235	$857,289	$871,343	$885,397	$899,451	$913,505	$927,559	$941,613	$955,667
Add: Log & Cant Purchases	$3,952,016	$4,017,883	$4,083,750	$4,149,617	$4,215,484	$4,281,351	$4,347,218	$4,413,085	$4,478,952	$4,544,819
Freight	$600,442	$610,449	$620,457	$630,464	$640,472	$650,479	$660,486	$670,494	$680,501	$690,508
Direct Labor	$1,079,218	$1,097,205	$1,115,192	$1,133,179	$1,151,166	$1,169,153	$1,187,140	$1,205,127	$1,223,114	$1,241,101
Indirect Expenses	$420,543	$427,552	$434,561	$441,570	$448,579	$455,588	$462,597	$469,606	$476,615	$483,624
	$6,881,401	$6,996,326	$7,111,250	$7,226,174	$7,341,098	$7,456,023	$7,570,947	$7,685,871	$7,800,795	$7,915,720
Less: Ending Inventory	$843,235	$857,289	$871,343	$885,397	$899,451	$913,505	$927,559	$941,613	$955,667	$969,721
Cost of Goods Sold	$6,038,166	$6,139,036	$6,239,906	$6,340,777	$6,441,647	$6,542,517	$6,643,388	$6,744,258	$6,845,128	$6,945,999
Gross Profit (Loss)	$2,394,189	$2,433,858	$2,473,527	$2,513,195	$2,552,864	$2,592,533	$2,632,202	$2,671,871	$2,711,540	$2,751,209
Expenses:										
Administration	$16,043	$16,310	$16,577	$16,845	$17,112	$17,379	$17,647	$17,914	$18,182	$18,449
Debt Payment	$50,935	$56,268	$62,160	$68,669	$75,860	$83,803	$92,579	$102,273	$112,982	$124,813
Depreciation	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468
Equipment Rental	$165,135	$167,887	$170,639	$173,392	$176,144	$178,896	$181,648	$184,401	$187,153	$189,905
Indirect Labor	$221,327	$225,016	$228,705	$232,394	$236,083	$239,771	$243,460	$247,149	$250,838	$254,527
Insurance	$74,073	$75,308	$76,542	$77,777	$79,011	$80,246	$81,480	$82,715	$83,949	$85,184
Interest	$310,347	$305,519	$300,185	$294,293	$287,784	$280,594	$272,650	$263,875	$254,181	$243,471
Maintenance & Repairs	$319,894	$325,225	$330,557	$335,889	$341,220	$346,552	$351,883	$357,215	$362,546	$367,878
Marketing	$230,090	$233,925	$237,760	$241,595	$245,429	$249,264	$253,099	$256,934	$260,769	$264,604
Operating Supplies	$59,993	$60,992	$61,992	$62,992	$63,992	$64,992	$65,992	$66,992	$67,992	$68,991
Payroll Taxes	$55,076	$55,994	$56,912	$57,830	$58,748	$59,666	$60,584	$61,502	$62,420	$63,338
Taxes	$2,607	$2,651	$2,694	$2,738	$2,781	$2,825	$2,868	$2,911	$2,955	$2,998
Total Expenses	$1,514,987	$1,534,563	$1,554,192	$1,573,880	$1,593,632	$1,613,456	$1,633,358	$1,653,348	$1,673,434	$1,693,626
Net Operating Income	$879,202	$899,294	$919,334	$939,315	$959,232	$979,077	$998,844	$1,018,523	$1,038,107	$1,057,583
Other Income:										
Total Other Income	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income (Loss)	$879,202	$899,294	$919,334	$939,315	$959,232	$979,077	$998,844	$1,018,523	$1,038,107	$1,057,583

Table 23. Income Statement for Years 21 - 30

	Yr21	Yr22	Yr23	Yr24	Yr25	Yr26	Yr27	Yr28	Yr29	Yr30
Revenue:										
Gross Sales	$9,837,747	$9,978,286	$10,118,825	$10,259,365	$10,399,904	$10,540,443	$10,680,982	$10,821,522	$10,962,061	$11,102,600
Less: Sales Returns	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Sales	$9,837,747	$9,978,286	$10,118,825	$10,259,365	$10,399,904	$10,540,443	$10,680,982	$10,821,522	$10,962,061	$11,102,600
Cost of Goods Sold:										
Beginning Inventory	$969,721	$983,775	$997,829	$1,011,883	$1,025,936	$1,039,990	$1,054,044	$1,068,098	$1,082,152	$1,096,206
Add: Log & Cant Purchases	$4,610,686	$4,676,553	$4,742,420	$4,808,287	$4,874,154	$4,940,021	$5,005,887	$5,071,754	$5,137,621	$5,203,488
Freight	$700,516	$710,523	$720,530	$730,538	$740,545	$750,553	$760,560	$770,567	$780,575	$790,582
Direct Labor	$1,259,088	$1,277,075	$1,295,062	$1,313,049	$1,331,036	$1,349,023	$1,367,010	$1,384,997	$1,402,984	$1,420,971
Indirect Expenses	$490,634	$497,643	$504,652	$511,661	$518,670	$525,679	$532,688	$539,697	$546,706	$553,715
	$8,030,644	$8,145,568	$8,260,492	$8,375,417	$8,490,341	$8,605,265	$8,720,189	$8,835,114	$8,950,038	$9,064,962
Less: Ending Inventory	$983,775	$997,829	$1,011,883	$1,025,936	$1,039,990	$1,054,044	$1,068,098	$1,082,152	$1,096,206	$1,110,260
Cost of Goods Sold	$7,046,869	$7,147,739	$7,248,610	$7,349,480	$7,450,350	$7,551,221	$7,652,091	$7,752,961	$7,853,832	$7,954,702
Gross Profit (Loss)	$2,790,878	$2,830,547	$2,870,216	$2,909,885	$2,949,554	$2,989,222	$3,028,891	$3,068,560	$3,108,229	$3,147,898
Expenses:										
Administration	$18,716	$18,984	$19,251	$19,518	$19,786	$20,053	$20,321	$20,588	$20,855	$21,123
Debt Payment	$137,882	$152,321	$168,271	$185,891	$205,356	$226,859	$250,614	$276,857	$305,848	$367,333
Depreciation	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468
Equipment Rental	$192,657	$195,410	$198,162	$200,914	$203,666	$206,419	$209,171	$211,923	$214,675	$217,428
Indirect Labor	$258,215	$261,904	$265,593	$269,282	$272,971	$276,659	$280,348	$284,037	$287,726	$291,415
Insurance	$86,419	$87,653	$88,888	$90,122	$91,357	$92,591	$93,826	$95,060	$96,295	$97,529
Interest	$231,641	$218,571	$204,133	$188,183	$170,563	$151,098	$129,594	$105,839	$79,597	$50,606
Maintenance & Repairs	$373,210	$378,541	$383,873	$389,204	$394,536	$399,867	$405,199	$410,530	$415,862	$421,194
Marketing	$268,438	$272,273	$276,108	$279,943	$283,778	$287,613	$291,447	$295,282	$299,117	$302,952
Operating Supplies	$69,991	$70,991	$71,991	$72,991	$73,991	$74,991	$75,991	$76,990	$77,990	$78,990
Payroll Taxes	$64,256	$65,174	$66,092	$67,009	$67,927	$68,845	$69,763	$70,681	$71,599	$72,517
Taxes	$3,042	$3,085	$3,129	$3,172	$3,216	$3,259	$3,303	$3,346	$3,389	$3,433
Total Expenses	$1,713,935	$1,734,374	$1,754,957	$1,775,697	$1,796,613	$1,817,722	$1,839,044	$1,860,602	$1,882,421	$1,933,986
Net Operating Income	$1,076,943	$1,096,173	$1,115,259	$1,134,187	$1,152,940	$1,171,500	$1,189,847	$1,207,958	$1,225,808	$1,213,912
Other Income:										
Total Other Income	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Income (Loss)	$1,076,943	$1,096,173	$1,115,259	$1,134,187	$1,152,940	$1,171,500	$1,189,847	$1,207,958	$1,225,808	$1,213,912

Table 24. First Year Balance Sheet

	Assets			
Current Assets:				
Cash			$1,696,040	
Inventory			$555,870	
	Total Current Assets			$2,251,910
Fixed Assets:				
Office Equipment		$19,413		
Less:	Accumulated Depreciation	$7,765	$11,648	
Equipment		$3,602,019		
Less:	Accumulated Depreciation	$1,030,177	$2,571,841	
Buildings		$540,986		
Less:	Accumulated Depreciation	$9,468	$531,519	
Land			$800,000	
	Total Fixed Assets			$3,915,008
Total Assets				$6,166,918
	Liabilities and Capital			
Long-Term Liabilities:				
Long-Term Notes Payable		$3,384,849		
	Total Long-Term Liabilities			$3,384,849
Total Liabilities				$3,384,849
Capital:				
Owner's Equity			$3,384,849	
Net Profit			($602,780)	
Total Capital				$2,782,069
Total Liabilities and Capital				$6,166,918

Table 25. Balance Sheet for Years 1 - 10

	Yr1	Yr2	Yr3	Yr4	Yr5	Yr6	Yr7	Yr8	Yr9	Yr10
Assests										
Current Assets:										
Cash	$1,696,040	$1,294,188	$1,620,481	$2,330,369	$3,058,200	$3,803,694	$4,566,545	$5,346,413	$6,142,924	$6,955,662
Inventory	$555,870	$609,238	$694,264	$744,858	$758,912	$772,966	$787,020	$801,074	$815,128	$829,182
Total Current Assets	$2,251,910	$1,903,425	$2,314,744	$3,075,227	$3,817,111	$4,576,660	$5,353,565	$6,147,487	$6,958,051	$7,784,844
Fixed Assets:										
Office Equipment	$19,413	$11,648	$6,989	$4,193	$2,516					
Less: Accumulated Depreciation	$7,765	$4,659	$2,795	$1,677	$1,006					
	$11,648	$6,989	$4,193	$2,516	$1,510					
Equipment	$3,602,019	$2,571,841	$1,836,295	$1,311,114	$936,136	$668,401	$477,238			
Less: Accumulated Depreciation	$1,030,177	$735,547	$525,180	$374,979	$267,735	$191,163	$136,490			
	$2,571,841	$1,836,295	$1,311,114	$936,136	$668,401	$477,238	$340,748			
Buildings	$540,986	$531,519	$522,051	$512,583	$503,115	$493,648	$484,180	$474,712	$465,244	$455,777
Less: Accumulated Depreciation	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468
	$531,519	$522,051	$512,583	$503,115	$493,648	$484,180	$474,712	$465,244	$455,777	$446,309
Land	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000
Total Fixed Assets	$3,915,008	$3,165,334	$2,627,891	$2,241,767	$1,963,558	$1,761,418	$1,615,460	$1,265,244	$1,255,777	$1,246,309
Total Assets	$6,166,918	$5,068,760	$4,942,635	$5,316,994	$5,780,670	$6,338,078	$6,969,025	$7,412,731	$8,213,828	$9,031,152
Liabilities and Capital										
Long-Term Liabilities:										
Long-Term Notes Payable	$3,384,849	$3,366,033	$3,345,247	$3,322,285	$3,296,918	$3,268,895	$3,237,937	$3,203,738	$3,165,958	$3,124,221
Total Long-Term Liabilities	$3,384,849	$3,366,033	$3,345,247	$3,322,285	$3,296,918	$3,268,895	$3,237,937	$3,203,738	$3,165,958	$3,124,221
Total Liabilities	$3,384,849	$3,366,033	$3,345,247	$3,322,285	$3,296,918	$3,268,895	$3,237,937	$3,203,738	$3,165,958	$3,124,221
Capital:										
Owner's Equity	$3,384,849	$2,782,069	$1,702,727	$1,597,388	$1,994,709	$2,483,752	$3,069,183	$3,731,088	$4,208,993	$5,047,870
Net Profit	($602,780)	($1,079,342)	($105,339)	$397,321	$489,042	$585,432	$661,905	$477,906	$838,877	$859,061
Total Capital	$2,782,069	$1,702,727	$1,597,388	$1,994,709	$2,483,752	$3,069,183	$3,731,088	$4,208,993	$5,047,870	$5,906,931
Total Liabilities and Capital	$6,166,918	$5,068,760	$4,942,635	$5,316,994	$5,780,670	$6,338,078	$6,969,025	$7,412,731	$8,213,828	$9,031,152

Table 26. Balance Sheet for Years 11 - 20

	Yr11	Yr12	Yr13	Yr14	Yr15	Yr16	Yr17	Yr18	Yr19	Yr20
Assests										
Current Assets:										
Cash	$7,784,171	$8,627,944	$9,486,424	$10,358,993	$11,244,969	$12,143,601	$13,054,055	$13,975,414	$14,906,661	$15,846,676
Inventory	$843,235	$857,289	$871,343	$885,397	$899,451	$913,505	$927,559	$941,613	$955,667	$969,721
Total Current Assets	$8,627,406	$9,485,233	$10,357,767	$11,244,390	$12,144,420	$13,057,106	$13,981,614	$14,917,027	$15,862,328	$16,816,397
Fixed Assets:										
Buildings	$446,309	$436,841	$427,373	$417,906	$408,438	$398,970	$389,503	$380,035	$370,567	$361,099
Less: Accumulated Depreciation	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468
	$436,841	$427,373	$417,906	$408,438	$398,970	$389,503	$380,035	$370,567	$361,099	$351,632
Land	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000
Total Fixed Assets	$1,236,841	$1,227,373	$1,217,906	$1,208,438	$1,198,970	$1,189,503	$1,180,035	$1,170,567	$1,161,099	$1,151,632
Total Assets	$9,864,247	$10,712,607	$11,575,673	$12,452,828	$13,343,391	$14,246,608	$15,161,649	$16,087,594	$17,023,427	$17,968,028
Liabilities and Capital										
Long-Term Liabilities:										
Long-Term Notes Payable	$3,078,114	$3,027,180	$2,970,911	$2,908,751	$2,840,082	$2,764,222	$2,680,419	$2,587,840	$2,485,567	$2,372,585
Total Long-Term Liabilities	$3,078,114	$3,027,180	$2,970,911	$2,908,751	$2,840,082	$2,764,222	$2,680,419	$2,587,840	$2,485,567	$2,372,585
Total Liabilities	$3,078,114	$3,027,180	$2,970,911	$2,908,751	$2,840,082	$2,764,222	$2,680,419	$2,587,840	$2,485,567	$2,372,585
Capital:										
Owner's Equity	$5,906,931	$6,786,133	$7,685,427	$8,604,761	$9,544,077	$10,503,309	$11,482,386	$12,481,230	$13,499,754	$14,537,860
Net Profit	$879,202	$899,294	$919,334	$939,315	$959,232	$979,077	$998,844	$1,018,523	$1,038,107	$1,057,583
Total Capital	$6,786,133	$7,685,427	$8,604,761	$9,544,077	$10,503,309	$11,482,386	$12,481,230	$13,499,754	$14,537,860	$15,595,444
Total Liabilities and Capital	$9,864,247	$10,712,607	$11,575,673	$12,452,828	$13,343,391	$14,246,608	$15,161,649	$16,087,594	$17,023,427	$17,968,028

Table 27. Balance Sheet for Years 21 - 30

	Yr21	*Yr22*	*Yr23*	*Yr24*	*Yr25*	*Yr26*	*Yr27*	*Yr28*	*Yr29*	*Yr30*
Assests										
Current Assets:										
Cash	$16,794,220	$17,747,924	$18,706,276	$19,667,607	$20,630,070	$21,591,629	$22,550,030	$23,502,787	$24,447,152	$25,350,630
Inventory	$983,775	$997,829	$1,011,883	$1,025,936	$1,039,990	$1,054,044	$1,068,098	$1,082,152	$1,096,206	$1,110,260
Total Current Assets	$17,777,995	$18,745,752	$19,718,159	$20,693,543	$21,670,061	$22,645,673	$23,618,128	$24,584,940	$25,543,358	$26,460,890
Fixed Assets:										
Buildings	$351,632	$342,164	$332,696	$323,228	$313,761	$304,293	$294,825	$285,357	$275,890	$266,422
Less: Accumulated Depreciation	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468	$9,468
	$342,164	$332,696	$323,228	$313,761	$304,293	$294,825	$285,357	$275,890	$266,422	$256,954
Land	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000	$800,000
Total Fixed Assets	$1,142,164	$1,132,696	$1,123,228	$1,113,761	$1,104,293	$1,094,825	$1,085,357	$1,075,890	$1,066,422	$1,056,954
Total Assets	$18,920,158	$19,878,448	$20,841,387	$21,807,304	$22,774,353	$23,740,498	$24,703,486	$25,660,829	$26,609,780	$27,517,844
Liabilities and Capital										
Long-Term Liabilities:										
Long-Term Notes Payable	$2,247,772	$2,109,889	$1,957,569	$1,789,298	$1,603,408	$1,398,052	$1,171,193	$920,578	$643,721	$337,874
Total Long-Term Liabilities	$2,247,772	$2,109,889	$1,957,569	$1,789,298	$1,603,408	$1,398,052	$1,171,193	$920,578	$643,721	$337,874
Total Liabilities	$2,247,772	$2,109,889	$1,957,569	$1,789,298	$1,603,408	$1,398,052	$1,171,193	$920,578	$643,721	$337,874
Capital:										
Owner's Equity	$15,595,444	$16,672,386	$17,768,559	$18,883,818	$20,018,005	$21,170,946	$22,342,446	$23,532,293	$24,740,251	$25,966,059
Net Profit	$1,076,943	$1,096,173	$1,115,259	$1,134,187	$1,152,940	$1,171,500	$1,189,847	$1,207,958	$1,225,808	$1,213,912
Total Capital	$16,672,386	$17,768,559	$18,883,818	$20,018,005	$21,170,946	$22,342,446	$23,532,293	$24,740,251	$25,966,059	$27,179,971
Total Liabilities and Capital	$18,920,158	$19,878,448	$20,841,387	$21,807,304	$22,774,353	$23,740,498	$24,703,486	$25,660,829	$26,609,780	$27,517,844

Vita

Brian Perkins is pursuing a PhD. in the Department of Wood Science & Forest Products at Virginia Tech. His research will determine factors that influence firm performance in the hardwood lumber industry. Brian also works part time for the Center for Forest Products Marketing and Management. Brian completed his M.S. in Wood Science and Forest Products at Virginia Tech in December 2006. His thesis research determined the economic feasibility of utilizing small diameter timber for solid wood and residue production. Brian Perkins attended West Virginia University where he earned a B.S. degree in Forestry with a concentration in Wood Science. Brian also attended Glenville State College where he earned an A.S. degree in Forest Technology. During the summer recesses of his college education, Brian worked for the WV Division of Forestry and Georgia Pacific. After graduating from WVU, Brian worked for an architectural woodworking company and a custom cabinet company in Winchester, VA for 2 1/2 years.

Education

Master in Science in Wood Science & Forest Products, Virginia Tech, Blacksburg, VA. Area of Concentration: Forest Products Marketing and Utilization. GPA: 3.73.

Bachelor in Science in Forestry, Wood Science Processing Option. West Virginia University, Morgantown, WV May 2001. GPA: 3.35.

Associate in Science in Forest Technology. Glenville State College, Glenville, WV. May 1997. GPA: 3.17

Career

Graduate Research Assistant. Department of Wood Science & Forest Products. Virginia Tech, Blacksburg, VA.

Workshop Manager. Westminster Woodworks, Winchester, VA.

Outside Salesperson. Winchester Woodworking Corporation, Winchester, VA.

Process Control Technician. Georgia Pacific, Mt. Hope, WV.

Student Waiter & Manager. West Virginia University, Morgantown, WV

Forestry Aide, W.V. Division of Forestry, Beckley, WV.