

# Introduction to Forest Products Supply Chain Management

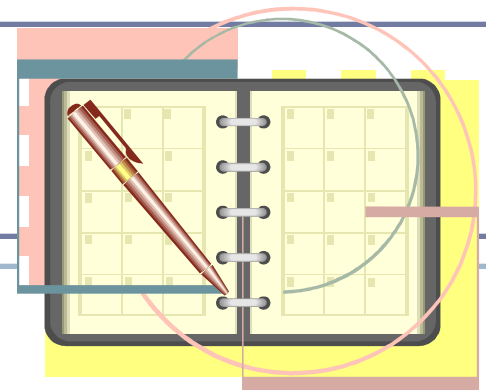


Images: T. Sowlati

Taraneh Sowlati, Ph.D., P. Eng.  
Associate Professor



# Outline



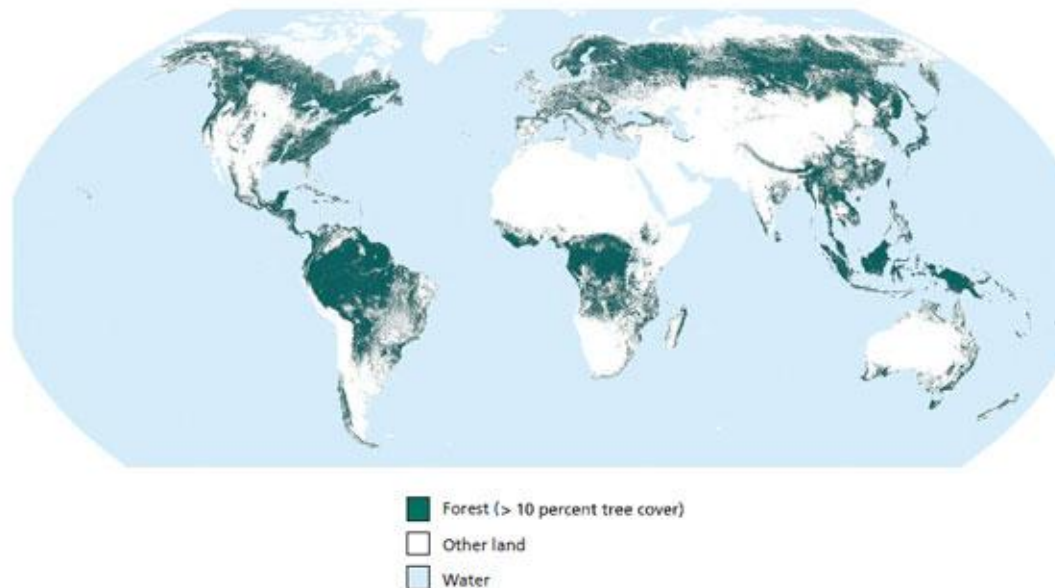
- ▶ Background
  - ▶ The forest industry, importance, challenges and opportunities
- ▶ Utilization of forest biomass and viability of bioenergy projects
- ▶ Supply chain management
- ▶ Forest products supply chain
- ▶ Models
- ▶ Issues and trends in modeling



# Forests – Global situation

- ▶ Forests cover 31% of the total land area on earth (FAO, Forestry Facts and Figures, 2011)

FIGURE 1  
The world's forests



Note: Tree cover derived from MODIS VCF\* 250 meter pixels for year 2005.

\* Moderate-resolution Imaging Spectroradiometer Vegetation Continuous Fields (Hansen et al. 2010).

Source: FAO, Global Forest Resources Assessment 2010



# Forests – Global situation

- ▶ Forests cover 31% of total land area on earth (FAO, Forestry Facts and Figures, 2011)
- ▶ More than 1.6 billion people depend on forests (FAO, Facts and Figures, 2011)



Source: FAO, R. Faidutti CFU000118

# Forests – Global situation

- ▶ **Forests cover 31% of total land area on earth** (FAO, The State of Forest Resources 2011)
- ▶ **More than 1.6 billion people depend on forests** (FAO, Facts and Figures, 2011)
- ▶ **Global employment in the formal forestry sector in 2006: 14 million people** (FAO, Facts and Figures, 2011)



Source: FAO, R. Faidutti CFU000660



# Forests – Global situation

- ▶ Forests cover 31% of total land area on earth (FAO, The State of Forest Resources 2011)
- ▶ More than 1.6 billion people depend on forests (FAO, Facts and Figures, 2011)
- ▶ Global employment in forestry sector: 18.2 million people (FAO, Contribution of the forestry sector to national economies 2008)
- ▶ Forests provide habitat for two-thirds of all species (FAO, Facts and Figures, 2011)



Source: Scott Ableman, CC BY-NC-ND 2.0  
<http://www.flickr.com/photos/ableman/>

Source: peupleloup, , CC BY-SA 2.0  
<http://www.flickr.com/photos/peupleloup/>



# Forestry

- Science, art and practice of understanding and managing forests to utilize forest resources in a sustainable manner (Source: UBC Faculty Website)



Source: FAO, C. Palmberg-Lerche FO-0477

# Forestry

- ▶ Science, art and practice of understanding and managing forests to utilize forest resources in a sustainable manner (Source: UBC Faculty of Forestry Website)

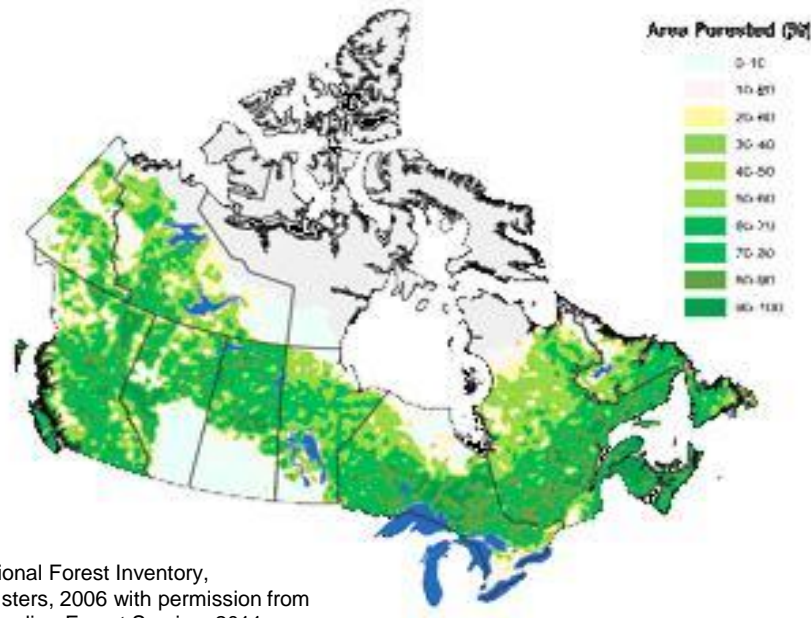
- ▶ **Values from forests**

- ▶ timber and other wood products
  - ▶ wildlife habitat
  - ▶ soil erosion control
  - ▶ carbon sequestration
  - ▶ employment
  - ▶ recreation
- Economic**
- Environmental**
- Social**



# Forestry in Canada

- ▶ Canada has 10% of the world's forests (NRCan 2011)
- ▶ 41% of Canada's surface area is forest



Reproduced from Canada's National Forest Inventory,  
Canadian Council of Forest Ministers, 2006 with permission from  
Natural Resources Canada, Canadian Forest Service, 2011.

# Forestry in Canada

- ▶ Canada has 10% of the world's forests (NRCan 2011)
- ▶ 41% of Canada's surface area is forest
- ▶ **Importance of the forest sector** (all data for 2010 from the FPAC website)
  - ▶ Generates more than \$57 billion revenues
  - ▶ Contributes more than \$23 billion to Canada's GDP
  - ▶ Creates about 600,000 direct and indirect jobs
  - ▶ 200 communities rely on the forest sector



# Forestry in British Columbia

BC: 10% of  
Canada's  
land surface



Reproduced with the permission of Natural Resources Canada 2001, courtesy of the Atlas of Canada



# Forestry in British Columbia

- ▶ BC: 10% of Canada's land surface
- ▶ Two-thirds of the province is covered by forests



Source: Ministry of Forests, Lands and Natural Resource Operations

# Forestry in British Columbia

- ▶ BC: 10% of Canada's land surface
- ▶ Two-thirds of the province is covered by forests
- ▶ Industry sales account for 43% of manufacturing shipment in BC and 13% of BC's GDP. (COFI. The forest Industry in BC. Economic Statistics. 2011)
- ▶ Forest products are the province's most important export commodity, accounting for 30% percent of the province's total export in 2009. (Ministry of Forests, Mines and Lands. The State of BC's Forests. 2010).



# Forest Industry in Canada

- ▶ Forestry and logging services
- ▶ Pulp and paper products industry
- ▶ Wood products industries



Source: Used with permission (2011), Ministry of Forests, Lands and Natural Resource Operations.

# Forest Industry in Canada

- ▶ Forestry and logging services
- ▶ Pulp and paper products industry
- ▶ Wood products industries



Source: Greg Hickman, "Irving Pulp and Paper Mill". CC BY-NC-ND 2.0.  
<http://www.flickr.com/photos/greghickman/3845265521/>



Source: Forest Products Association of Canada, FPAC\_MILLS\_ABIBO-10736,  
[fpac.ca](http://fpac.ca)

# Forest Industry in Canada

- ▶ Forestry and logging services
- ▶ Pulp and paper products industry
- ▶ Wood products industries



Sowlati

Lumber produced in BC

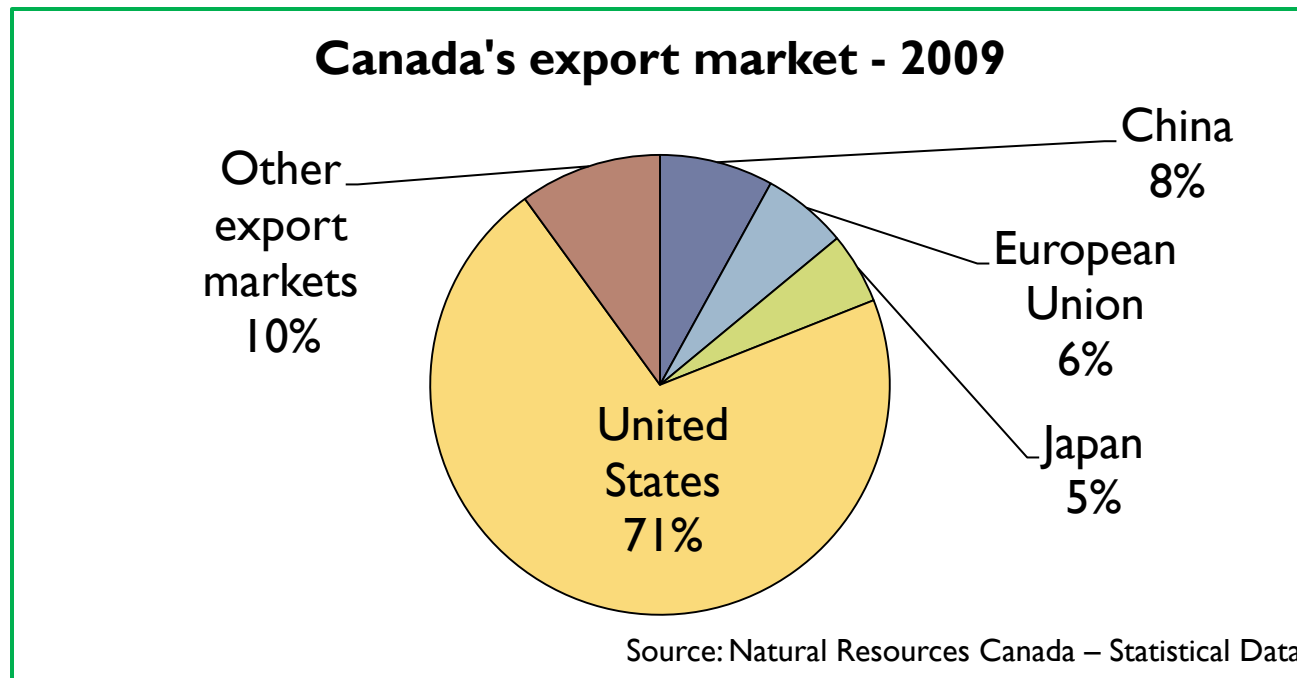


Source: APA The Engineered Wood Association

I-Joist floor system

# An Export Oriented Industry

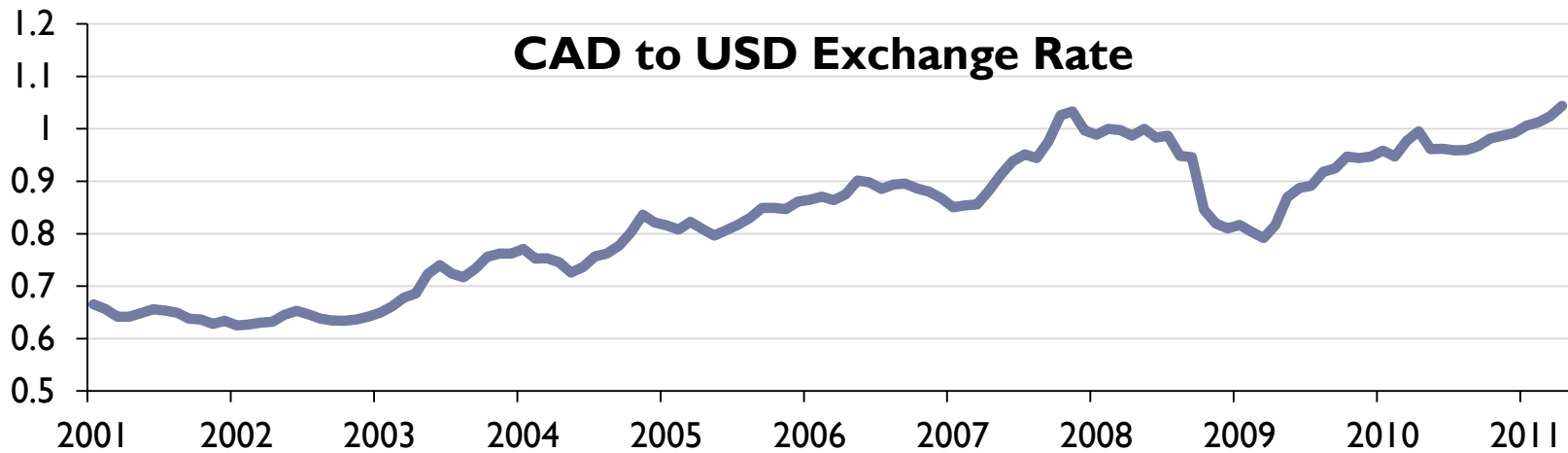
- ▶ Canada is one of the world's largest exporters of forest products (export value > \$23 billion in 2009).
- ▶ The US is the largest buyer of our forest products.



# Challenges

## ► Canadian dollar to US dollar exchange rate

ALL-TIME LOW/ HIGH		
Low	Jan. 21, 2002	\$1 CAD = 0.6179 US
High	Nov. 7, 2007	\$1 CAD = 1.1030 US



Source: Bank of Canada



# Challenges

- ▶ Canadian dollar to US dollar exchange rate
- ▶ Decline in housing starts in the US and real estate meltdown
- ▶ Global competition and emergence of low cost producers
- ▶ High fiber and energy costs
- ▶ Decline in newsprint demand
- ▶ Mountain pine beetle (MPB) in BC



# Background on MPB

- ▶ A small insect, less than 1 cm long, lives under the bark of pine trees
- ▶ Normally these insects play an important role in the life of a forest.
- ▶ Outbreak reasons:
  - ▶ Fire suppression
  - ▶ Mature lodgepole pine
  - ▶ Global warming



Source: Used with permission (2011), Ministry of Forests, Lands

and Natural Resource Operations.



# Mountain Pine Beetle

- ▶ BC Ministry of Forests and Range estimated in 2009
  - ▶ Cumulative area affected: 16.3 million hectares
  - ▶ Cumulative total: 675 million m<sup>3</sup> of timber
  - ▶ Projection: 69% of total merchantable pine volume would be killed by 2015

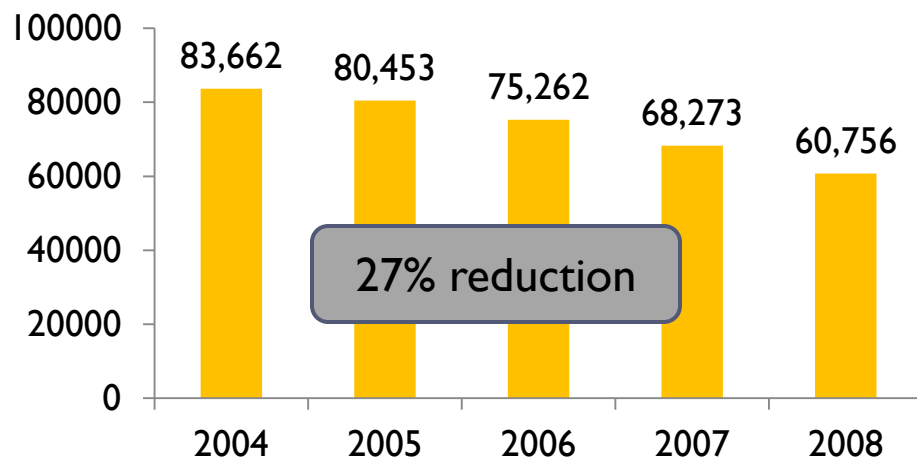


Images: J. Innes

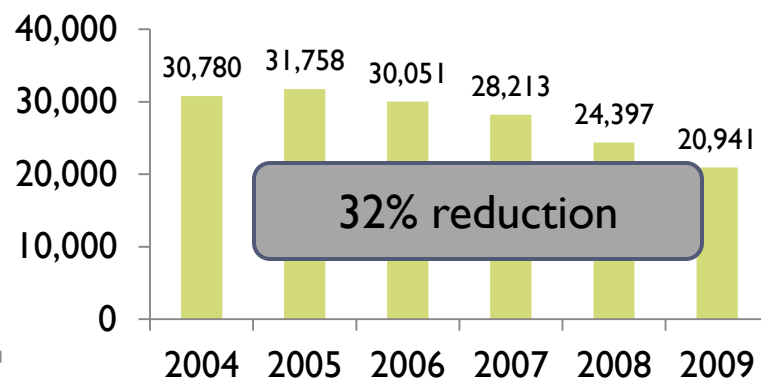
# Economic Impact - Canada

Source: Natural Resources Canada

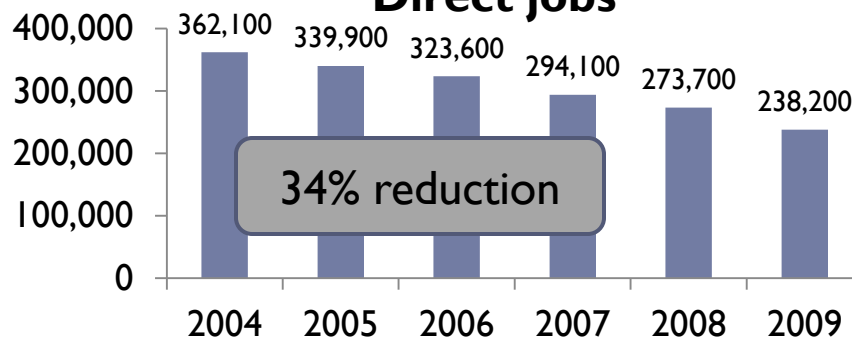
**Revenue from goods manufactured (Million\$)**



**Contribution to GDP (Million\$)**

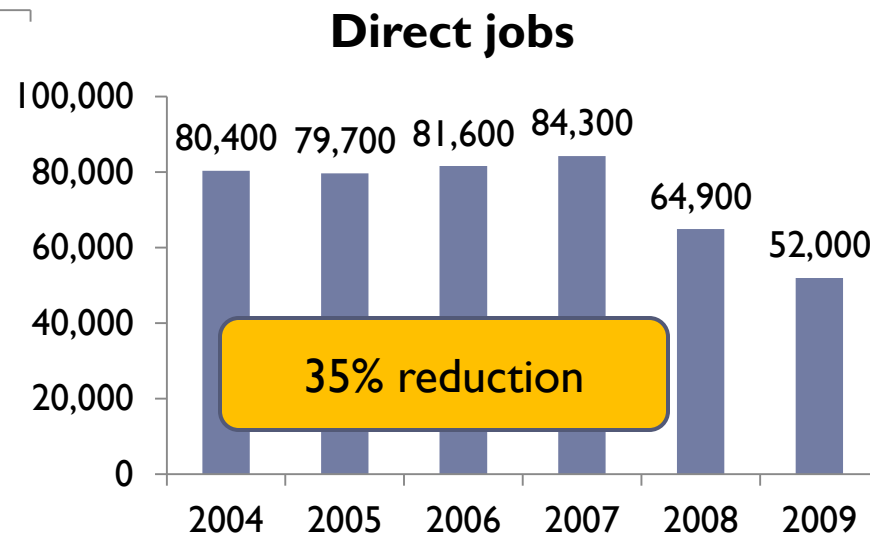
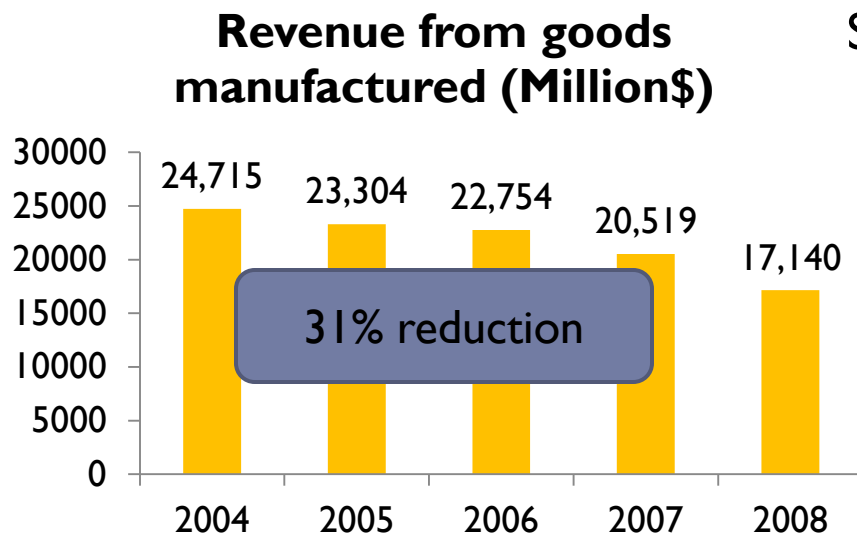


**Direct jobs**



# Economic Impact - BC

Source: Natural Resources Canada



# New Opportunities

- ▶ Canada and BC have enormous biomass resources
- ▶ Mountain pine beetle can be a platform to develop the bioenergy industry in BC
- ▶ The Province has developed a bioenergy strategy to promote new sources of sustainable and renewable energy, and to take advantage of pine beetle-attacked timber.



► **Key findings of a new study (Biopathways) from the Forest Products Association of Canada (FPAC) in Feb. 2011:**

- Numerous viable options exist to convert forest biomass to bio-energy, bio-chemicals and bio-material.
- These options are best achieved by integrating their production with the traditional forest industry

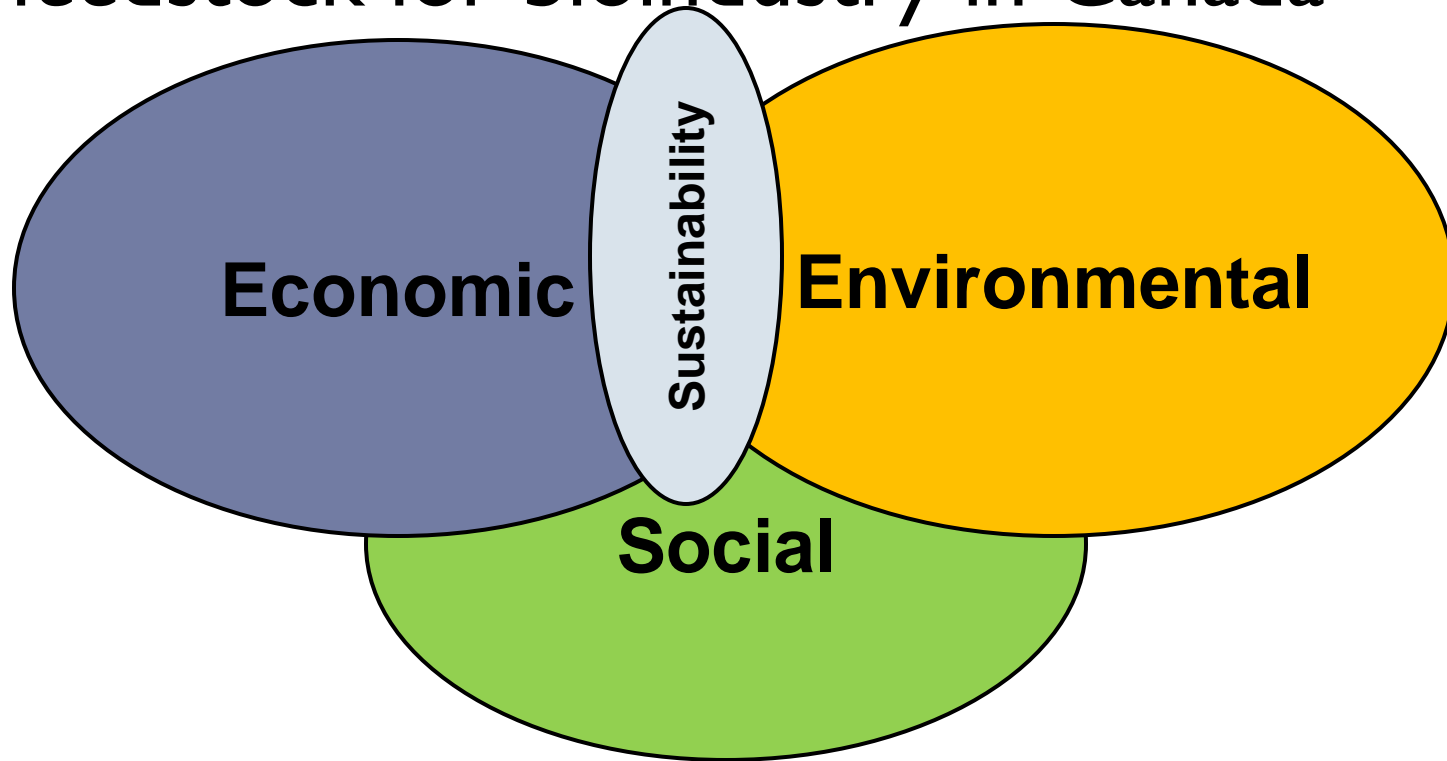
**The forest industry can be a surprisingly innovative player in the new bio-economy.**

Source: Canada News Wire Press Release – February 3, 2011



# Forest Biomass

- Drivers of attention to forest biomass as a feedstock for bioindustry in Canada



# Viability of a bio-energy project

- ▶ Affected by many different factors
- ▶ Feasibility
  - ▶ Feedstock availability
  - ▶ Feedstock cost
  - ▶ Feedstock quality



# Forest residues in Williams Lake

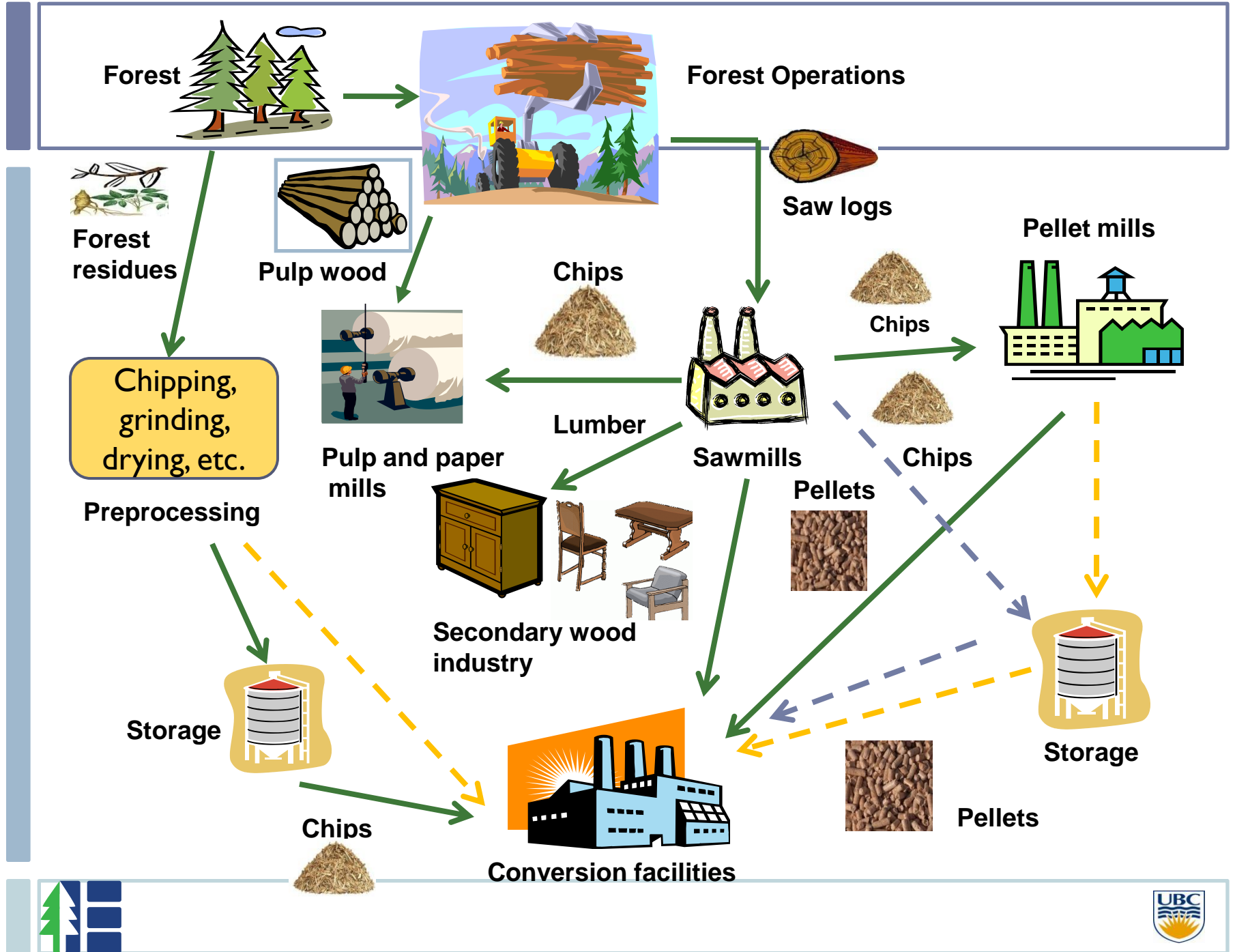


Image: Sowlati

# Important questions to answer

- ▶ Characteristics of feedstock required by the conversion facility
- ▶ Feedstock supply
- ▶ Management practices to produce forest biomass
- ▶ Harvesting system to choose
- ▶ Processing/ transportation/ separations systems to use
- ▶ Processing/ storage locations
- ▶ Affect on the current forest products mix

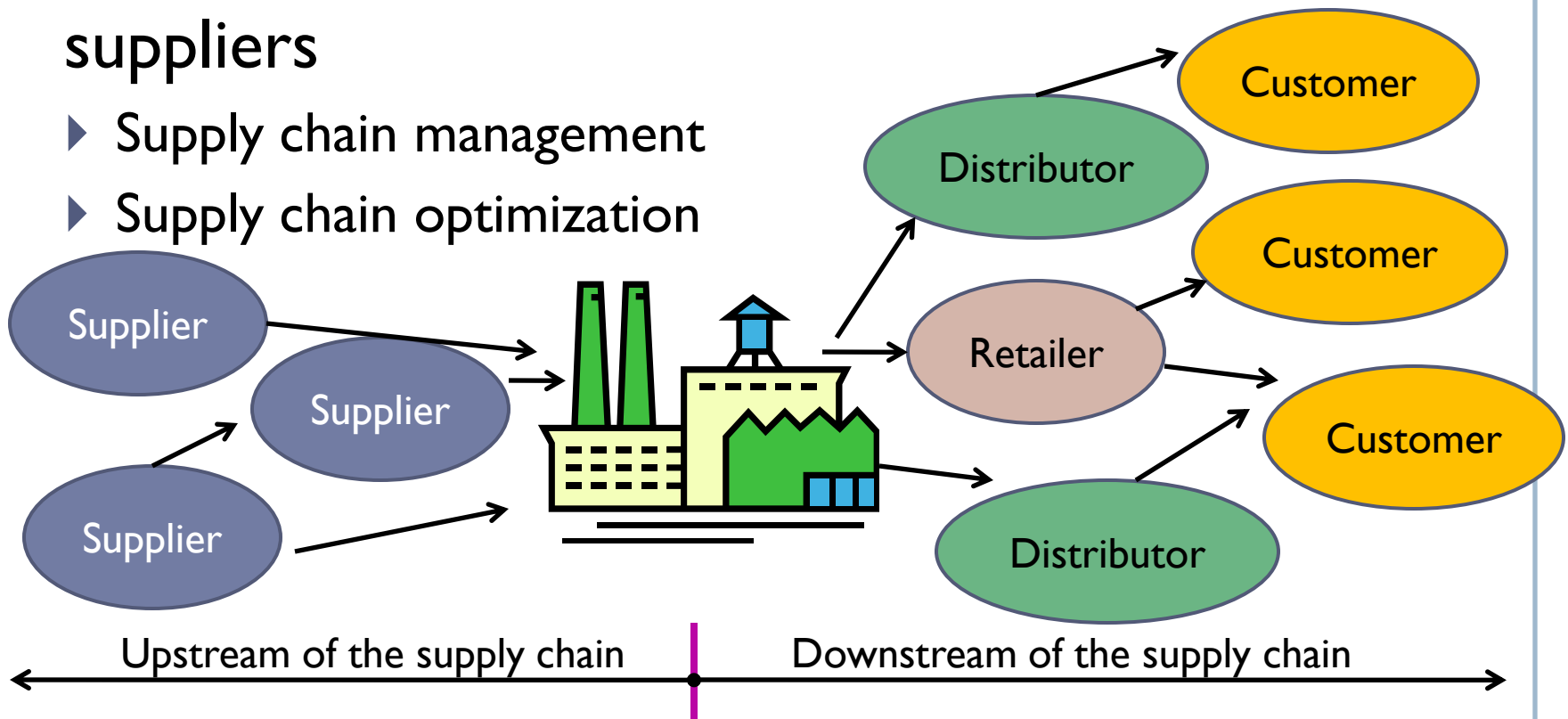




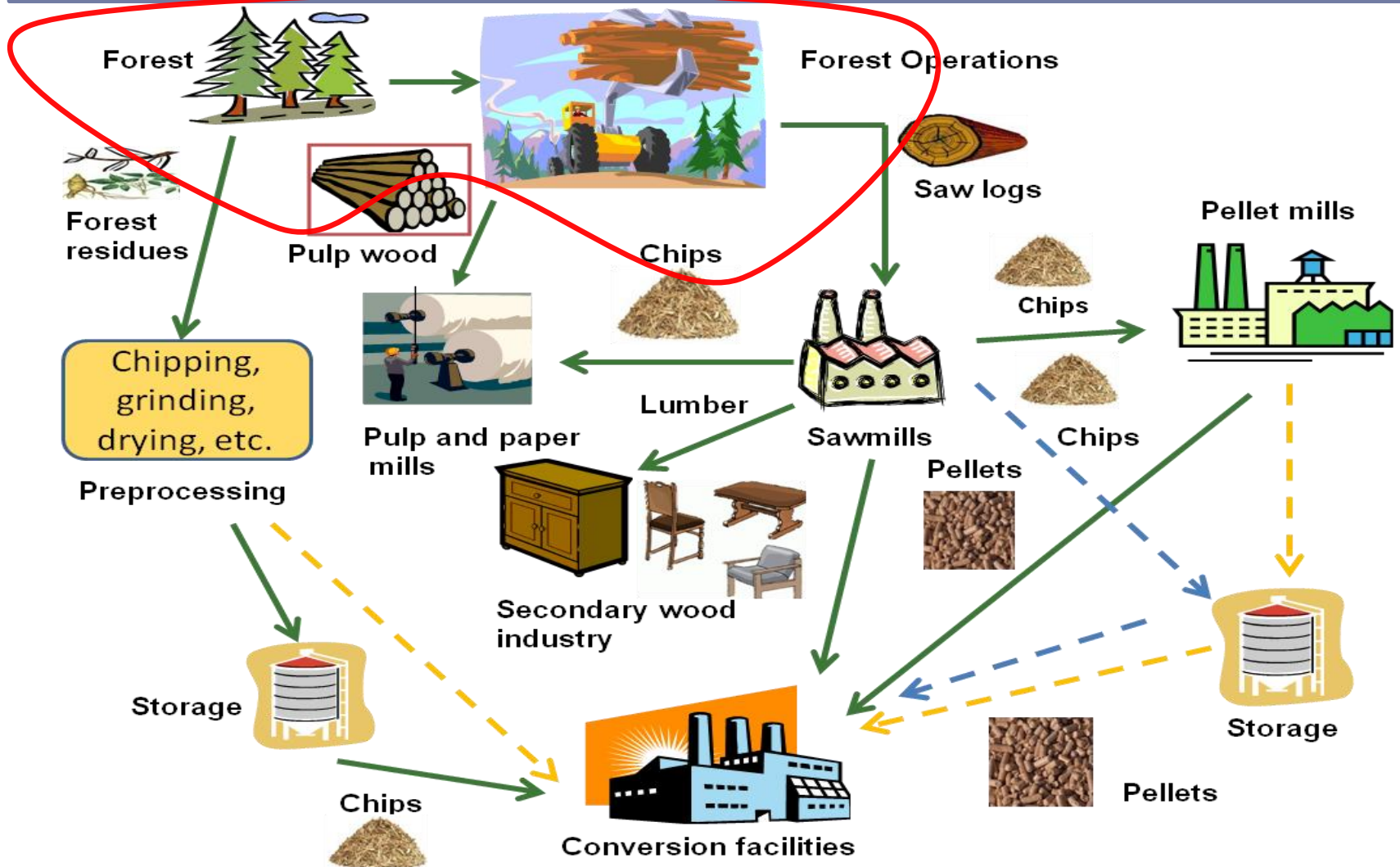
# Supply Chain

- ▶ The network of organizations that extend downstream to customers and upstream to suppliers

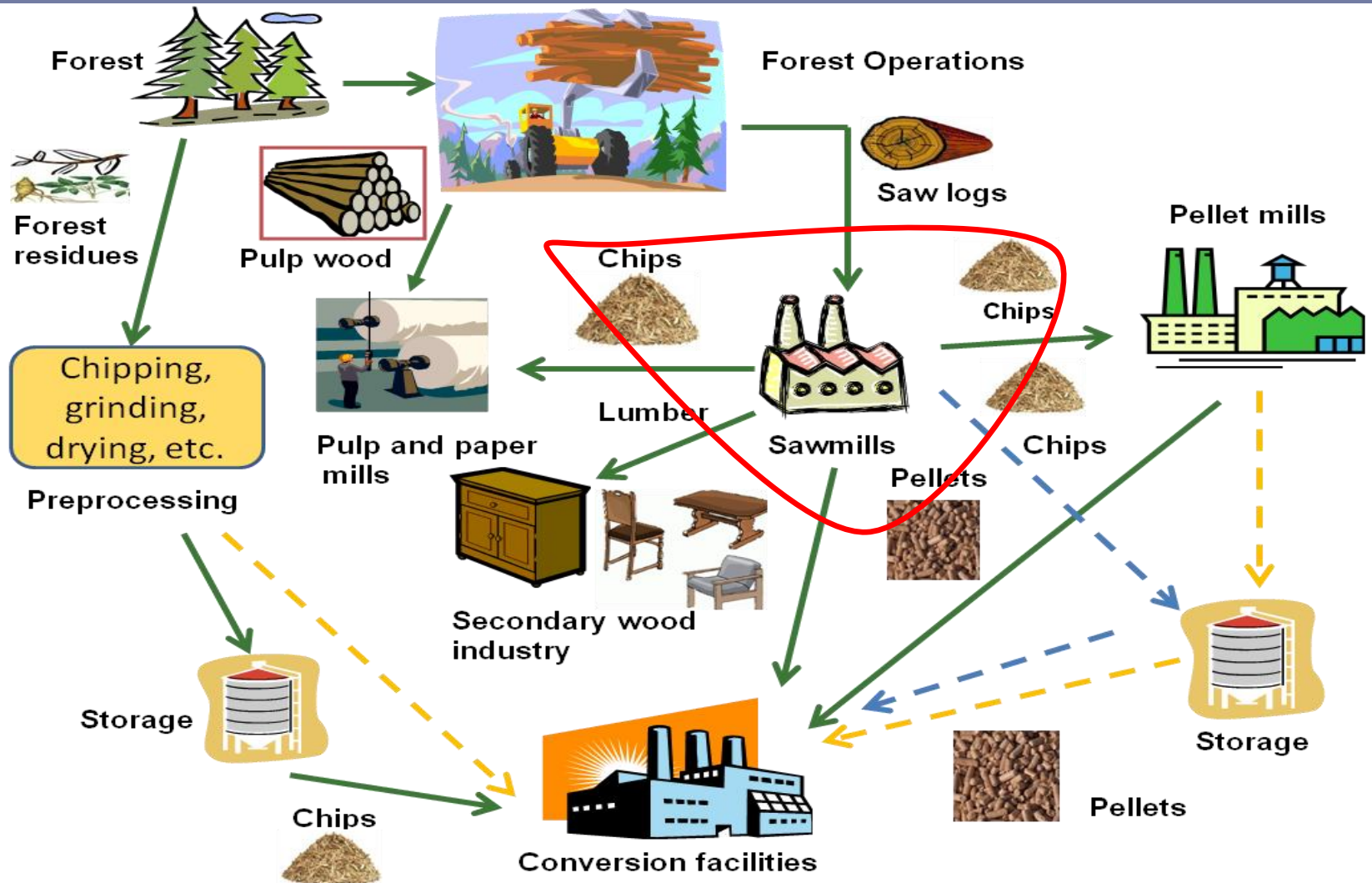
- ▶ Supply chain management
- ▶ Supply chain optimization



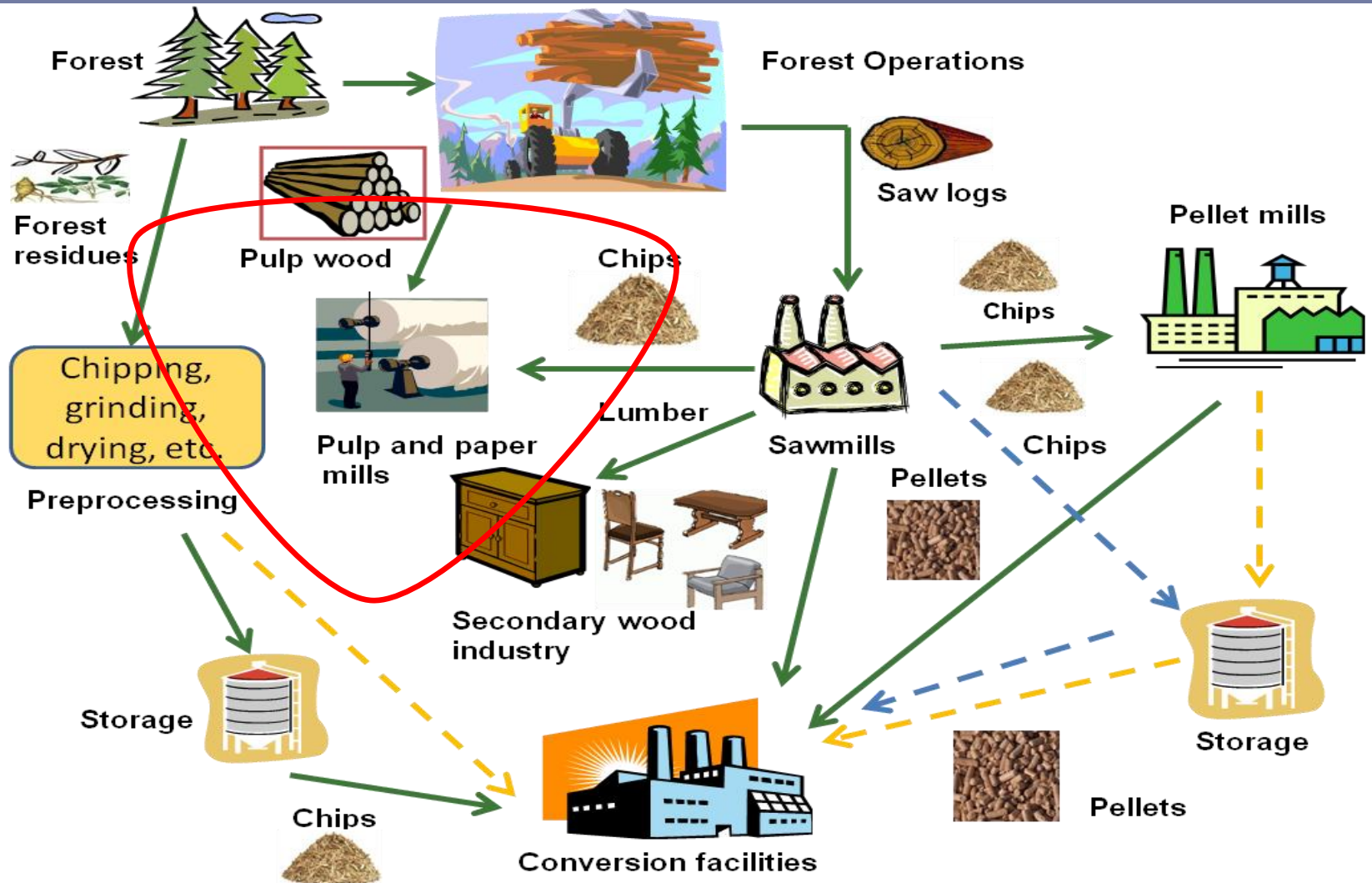
# Forest products supply chain



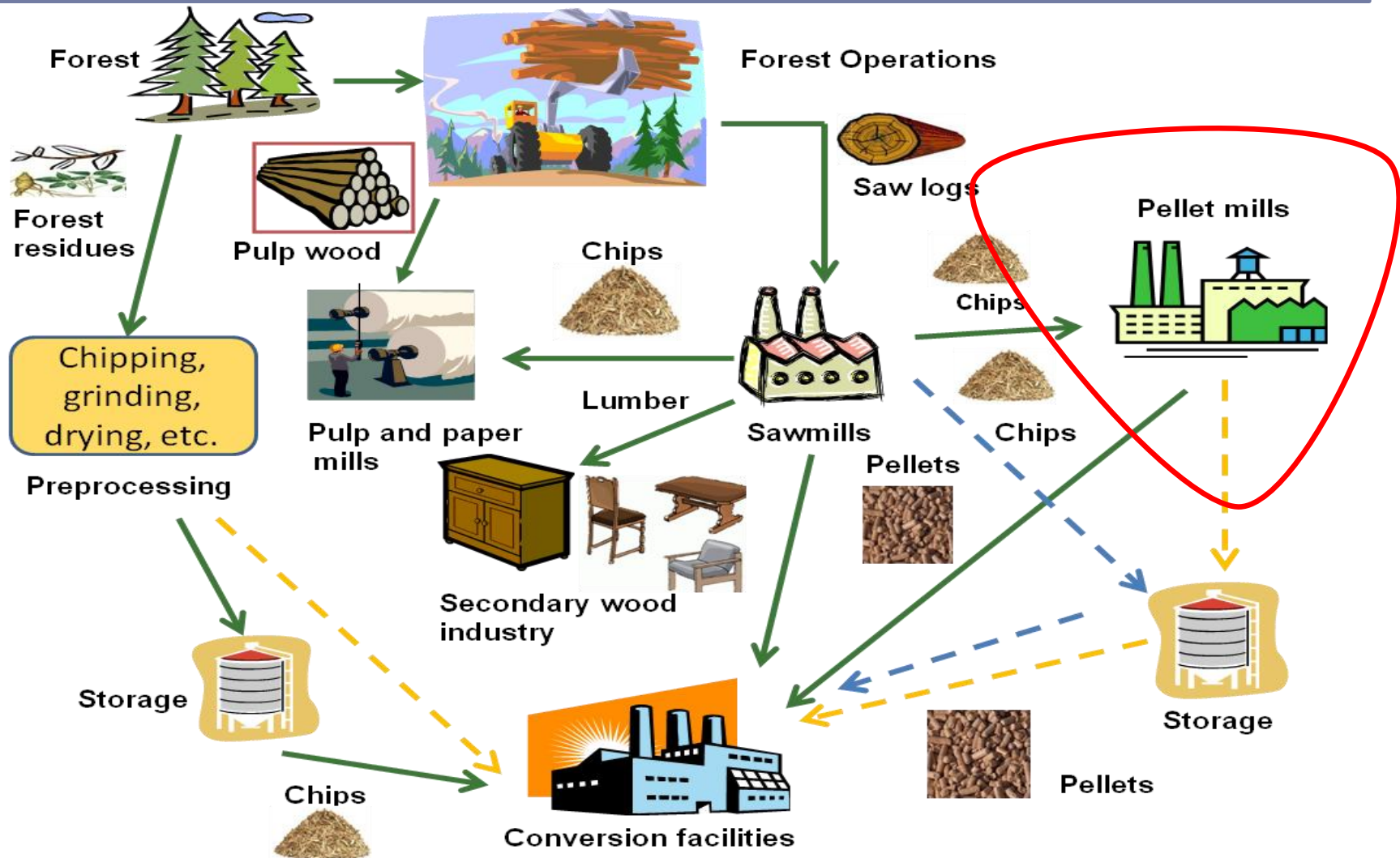
# Forest products supply chain



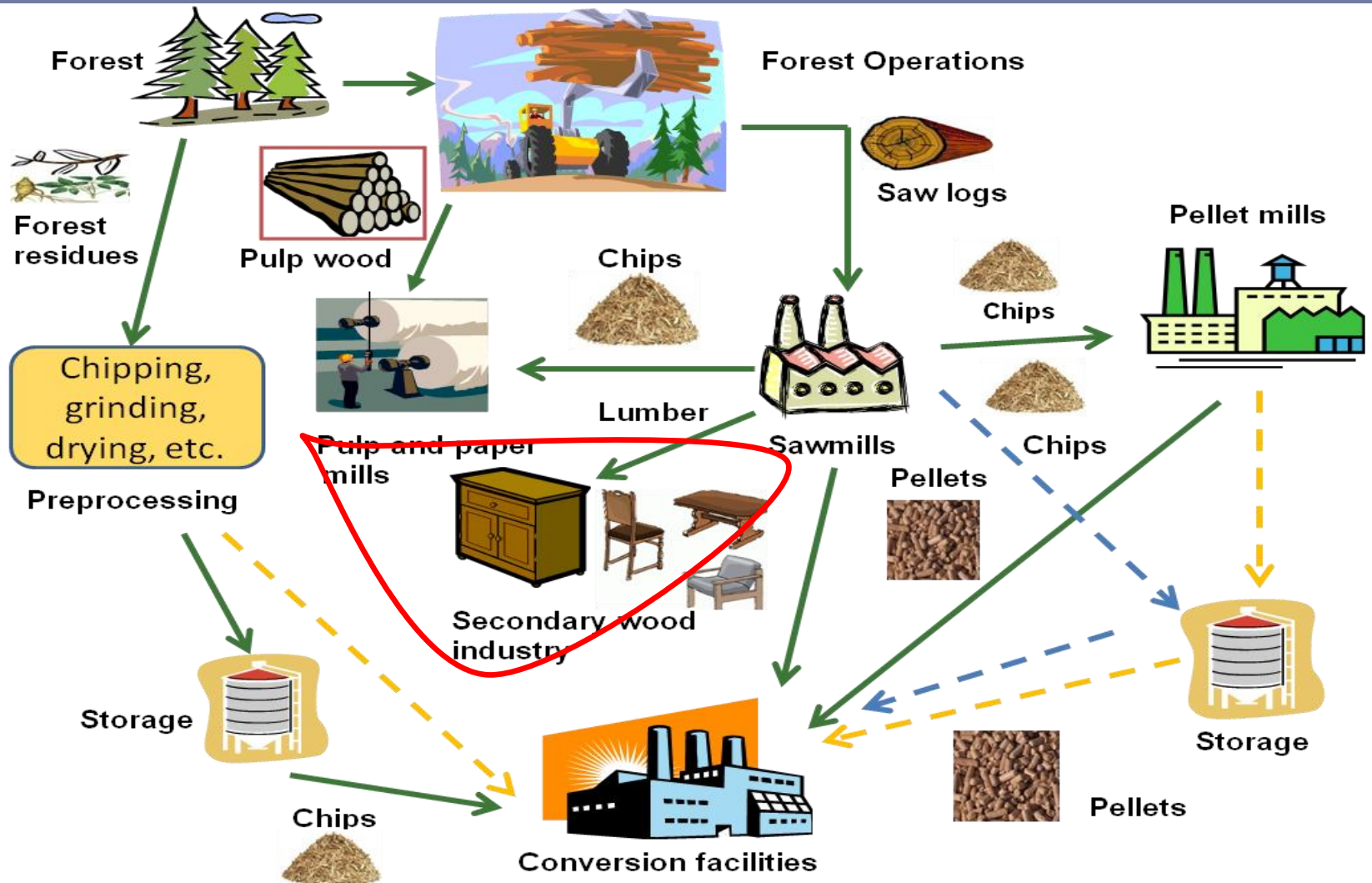
# Forest products supply chain



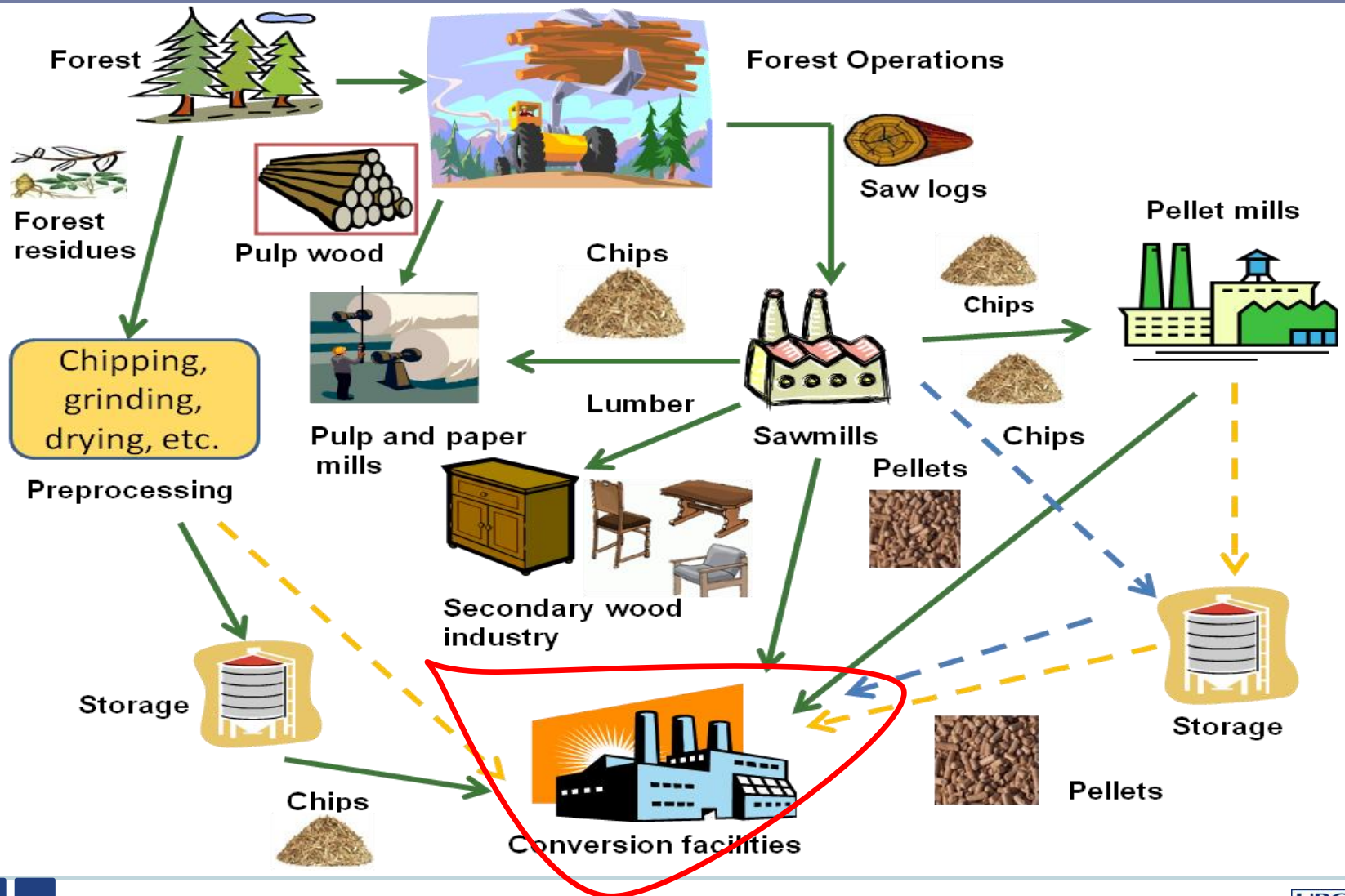
# Forest products supply chain



# Forest products supply chain



# Forest products supply chain



# Decision making levels

## ▶ Long-term (strategic level)

- ▶ Long-term harvest planning
- ▶ Plant location
- ▶ Investment decisions
- ▶ Road construction

## ▶ Medium-term (tactical level)

- ▶ Annual harvest planning
- ▶ Production planning
- ▶ Inventory management
- ▶ Road upgrade

## ▶ Short-term (operational level)

- ▶ Staff scheduling
- ▶ Truck scheduling
- ▶ Bucking
- ▶ Process control



# Operation and production planning

## ▶ Sawmills

- ▶ Log bucking: how to buck logs to meet the demand

## ▶ Pulp and paper mills

- ▶ Paper roll-cutting: how to cut the paper rolls to minimize the number of rolls used to satisfy the demand
- ▶ Process control: how much chemical to add at each process step to get a desired brightness of the pulp

## ▶ Veneer and plywood mills

- ▶ Product mix: determine the optimum mix of logs to use to maximize profit while meeting demand



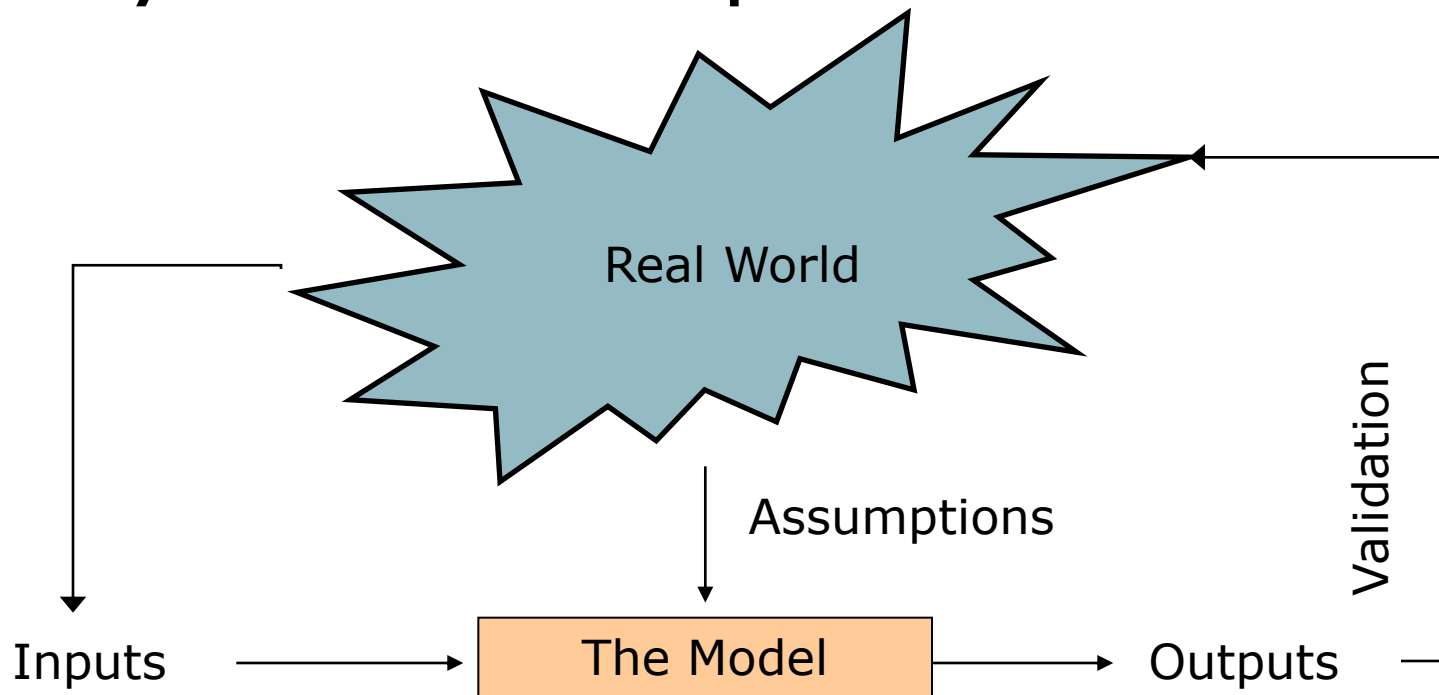
# Characteristics of forest supply chains

- ▶ Different types of products
- ▶ Demand driven products and by-products
- ▶ Different manufacturing processes
- ▶ Different markets and types of customers
- ▶ Different values
- ▶ Different planning horizons
- ▶ Wood as a natural material



# Models

- ▶ What is a model?
- ▶ Why do we develop a model?



# Types of Models

## ► Iconic models

- Photographs, maps, globes



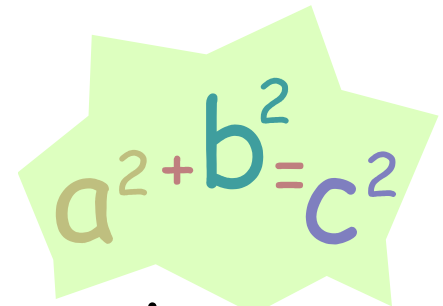
## ► Analog models

- Flowcharts, graphs



## ► Symbolic models

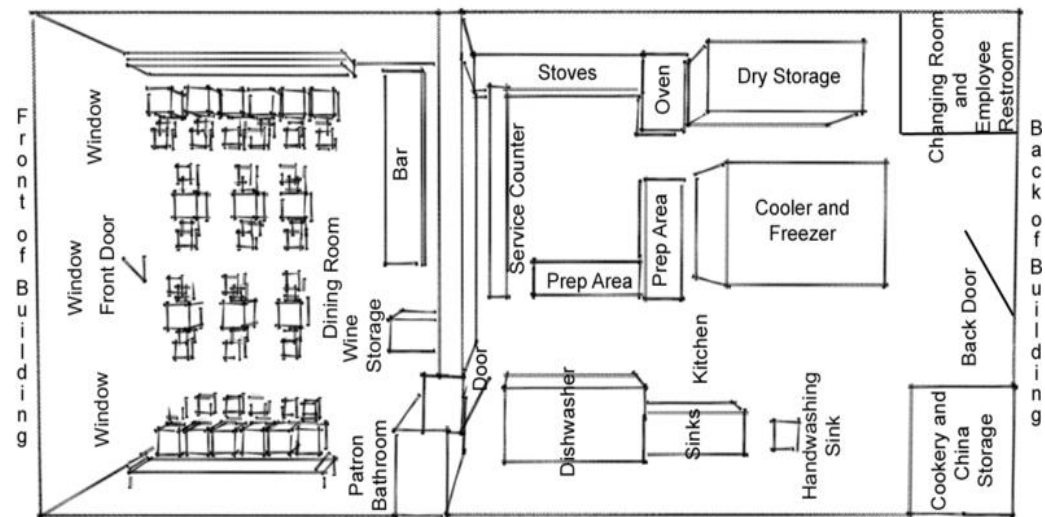
- Chemical formulae, mathematical equations


$$a^2 + b^2 = c^2$$

# Uses of models

- ▶ In general, a model is used to analyze a problem
  - ▶ Communication
  - ▶ Training and instruction
  - ▶ Prediction
  - ▶ Decision making

Floor plan



Source: Evil Jess, CC BY-NC-SA 2.0  
<http://www.flickr.com/people/pennydinawoods/>

# Uses of models

- ▶ In general, a model is used to analyze a problem
  - ▶ Communication
  - ▶ Training and instruction
  - ▶ Prediction
  - ▶ Decision making

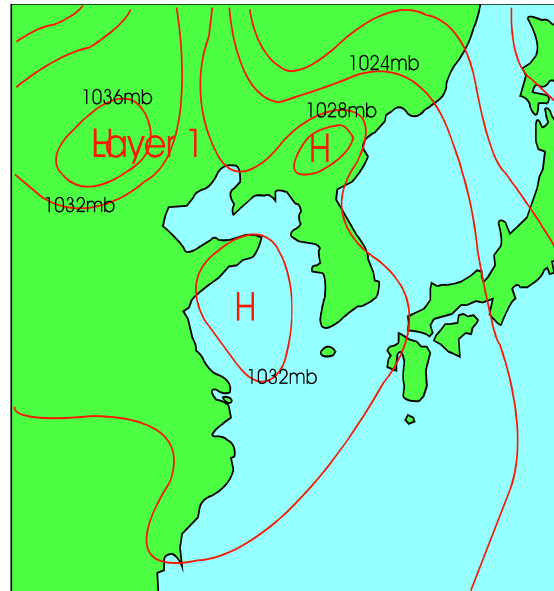


Source: cvander, "Google Flight Simulator", CC BY 2.0.  
<http://www.flickr.com/photos/cvander/1346126305/>

Flight Simulator

# Uses of models

- ▶ In general, a model is used to analyze a problem
  - ▶ Communication
  - ▶ Training and instruction
  - ▶ Prediction
  - ▶ Decision making



# Uses of models

- ▶ In general, a model is used to analyze a problem
  - ▶ Communication
  - ▶ Training and instruction
  - ▶ Prediction
  - ▶ Decision making



# Guidelines in formulating a model

- ▶ Assumptions
- ▶ Validity
- ▶ Trade-off between accuracy and utility
- ▶ Garbage in, garbage out
- ▶ Iterative process



# Issues and trends in forest products supply chain modeling

- ▶ Acquiring data is not straightforward
- ▶ Uncertainties exist in future prices, tree growth, and disasters such as fires and pests, but are difficult to consider
- ▶ Multiple objectives and multiple decision making groups
- ▶ Increased attention to environmental issues and incorporating them into the models
- ▶ Increased attention to supply chain modeling
- ▶ Complexity in integrating the strategic, tactical and operational decisions
- ▶ Opportunities to use wood biomass for energy generation



# Summary

- ▶ The forest industry is an important sector in Canada.
- ▶ There is a great opportunity for this sector to play a leading role in the development and establishment of the new bioindustry in Canada.
- ▶ A thorough assessment of bioenergy projects should incorporate multiple criteria.
- ▶ A systematic coordination of the whole supply chain is required for performance improvement.



# References

- ▶ COFI. 2011. The Forest Industry in BC. Economic Statistics. ([http://www.cofi.org/forest\\_industry\\_BC/economic\\_statistics.htm](http://www.cofi.org/forest_industry_BC/economic_statistics.htm))
- ▶ FAO. 2008. Contribution of the Forestry Sector to National Economies, 1990–2006, by A. Lebedys. Forest Finance Working Paper FSFM/ACC/08. Rome.
- ▶ FAO. 2011. State of the World's Forests. 2011. Rome.
- ▶ FAO. Forestry Facts and Figures. 2011 (<http://www.fao.org/forestry/28679/en/>)
- ▶ FPAC. 2011. (<http://www.fpac.ca/index.php/en/industry-by-the-numbers/>)
- ▶ D'Amours S., Rönnqvist M. and Weintraub. 2008. Using Operational Research for supply chain planning in the forest product industry. Information Systems and Operational Research (INFOR), 46: 265-281.
- ▶ Dykstra, D.P. 1984. Mathematical Programming for Natural Resource Management. McGraw Hill Inc. USA.
- ▶ Martell, D.L., Gunn, E.A., and Weintraub, A. 1998. Forest management challenges for operational researchers. European Journal of Operational Research, 104: 1-17.
- ▶ NRCan. 2011. Important Facts on Canada's Natural Resources. Forests. (<http://www.nrcan.gc.ca/stat/forest-eng.php>)
- ▶ NRCan. 2011. Canada's Forests – Statistical Data. (<http://canadaforests.nrcan.gc.ca/statsprofile/trade/ca>)
- ▶ Rönnqvist, M. 2003. Optimization in forestry. Mathematical Programming, 97: 267-284.
- ▶ The New Face of the Canadian Forest Industry – The Bio-pathways project. FPAC. Feb. 2011
- ▶ The State of BC's Forests. 2010. Third Edition. Ministry of Forests, Mines and Lands
- ▶ Weintraub, A., Romero, C., and Bjørndal, T. 2007. Handbook of Operations Research in Natural Resources. Springer.
- ▶ Weintraub, A. and Romero, C. 2006. Operations research models and the management of agricultural and forestry resources: a review and comparison. Interfaces, 36: 446-457.

