Supply Chain Analytics for Biomass Logistics

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4 November, 2015

Renewable Fuel Standard (RFS)

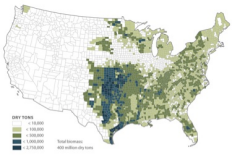
- **RFS was authorized under the Energy Policy Act(EPAct) of 2005**
  - Required that **7.5 billion** US gallons of transportation fuel come from renewable resources by 2012
- **Energy Independence and Security Act of 2007**
  - Reinforcement of energy consumption reduction goals
  - Raised renewable fuel target volume to **36 billion** US gallons by 2022

RFS Goals

- **Policy is based on scientific and economic research and forecasts which showed that renewable fuels will:**
  - Move the United States toward greater energy independence and security
  - Add more than $1.7 trillion to our Gross Domestic Product (GDP) between 2008 and 2022
  - Reduce greenhouse gases

Geographical Research Area

- **USDA estimated the contribution to RFS comparing five geographical regions**
  - Southeast: 49.0%
  - Central-Eastern: 43.3%
  - Northwest: 4.6%
  - Northeast: 2.0%
  - Western: <0.3%

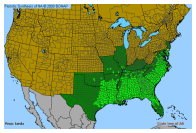


Biomass

"Organic matter, especially plant matter, that can be converted to fuel and is therefore regarded as a potential energy source."

Focus on : **Loblolly pine** *(Pinus taeda)*

- *Evergreen coniferous*
- *Grows on infertile ground*
- *Short rotation timber*

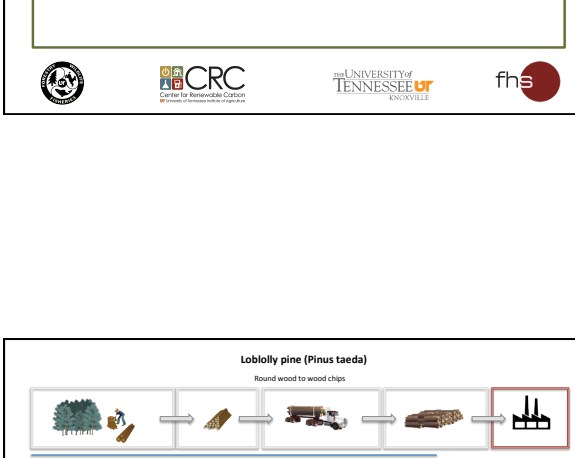


Thesis Objectives

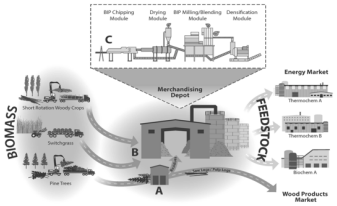
1. Defining the upstream of the supply chain for southern pine
2. Defining midstream issues of biomass supply chain
3. Creation of an Excel simulation spreadsheet
4. Application of Taguchi Loss Function
5. Make recommendations for using SPC/Lean
6. General comparisons of logistics supply chain for southern pine and switchgrass (from the literature)

Research Hypothesis

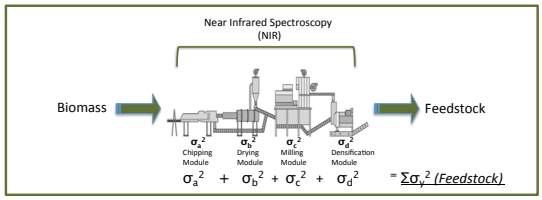
"Application of SPC and related tools into biomass logistics of the pine supply chain lowers cost and reduces variability of key components."



The Supply Chain



Bio Depot



Galton's Theory

- **Galton's Theory of Components of Variance, *e.g.*, (X, Y) dependent :**

Independent: $Var(X + Y) = VarX + VarY$

Dependent: $Var(X + Y) = VarX + VarY \pm 2Cov(X,Y)$

or,

$Var(aX + bY) = a^2VarX + b^2VarY \pm 2abCov(X,Y)$

Methods

- **SPC/Lean principles**
  - to reduce variation on **"high variation"** which are also the **"high cost"** components of the supply chain
- **Root- Cause Analysis**
  - FMEA, Ishikava
- **Taguchi Loss Function**

SPC Principles

- **To reduce variability SPC provides tools, those are:**
  - Cause and Effect Diagrams (or Fishbone)
  - Control Charts
  - Flow Charts
  - Histograms
  - Pareto Charts
  - Probability Plots

Lean Tools

- **7 Types of Waste**
  - Overproduction
  - Waiting
  - Transport
  - Motion
  - Processing
  - Inventory
  - Defects

Root-Cause Analysis

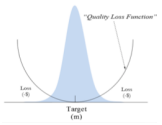
Failure Mode and Effect Analysis:

- Steps in the process
- Failure modes
- Failure causes
- Failure effects

Ishikawa or Fishbone Diagram:

Taguchi Loss Function

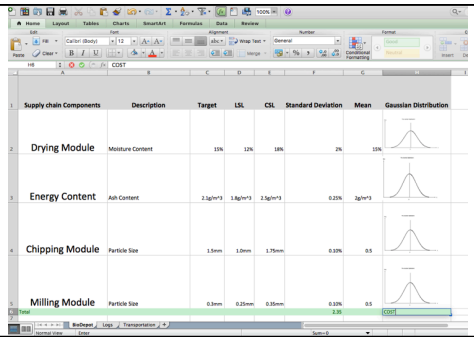
- Variance is a cost factor
- Taguchi Loss Function quantifies cost of variability in the system



L(y)=k*(y-m)²
Where:
L = loss in dollars when the quality characteristic is equal to ***y***
y = the value of the quality characteristic (*e.g.*, moisture, ash content, density, etc.)
m = target value of ***y***
k = constant

Excel Spread Sheet

- The spread sheet will emphasize
  - Simulated variability of components
  - Estimated cost
  - Sensitivity analysis according to root-cause schema



Supply chain Components	Description	Target	LSL	CSL	Standard Deviation	Mean	Gaussian Distribution
Drying Module	Moisture Content	15%	12%	18%	2%	15%	
Energy Content	Ash Content	2.1g/m^3	1.8g/m^3	2.5g/m^3	0.25%	2g/m^3	
Chipping Module	Particle Size	1.5mm	1.0mm	1.75mm	0.10%	0.5	
Milling Module	Particle Size	0.3mm	0.25mm	0.35mm	0.10%	0.5	
Total					2.35	COST	

Thank you for your attention!

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