Feedstock Supply Chain Logistics in the Southeastern US

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Integrated Feedstock Solution

Over nearly a decade, Genera has developed the country's leading purpose-grown biomass supply chain, fully integrated from identification, recruitment and management of land through crop establishment, annual management, harvesting, logistics and transportation, inventory management, material handling, and mechanical sizing and processing

- Genera has completed dozens of projects focused on biomass feedstock development and supply for fuel, chemicals, electricity and other product applications; seven of these projects involved over 100,000 tons of annual biomass feedstock supply
- Specific customers Genera has served include three of the ten largest oil and gas companies in the world, five Fortune 500 companies, two of the world's largest livestock producers, an international biopower corporation, and several small to medium sized privately held companies
- Developed partnerships and collaborations with leading ag producer groups, equipment manufacturers, seed and input suppliers, processing equipment vendors
- Extensive variety trials and demonstration plots across the U.S., with multiple partners

Agrished® Management | **Supply ASSURE® System** | **BIN-SPEC® Processing**

Broad Feedstock Experience

- Perennial Herbaceous Crops
  - Switchgrass
  - Wide Hybrids
  - Energy Cane
  - Miscanthus

- Annual Energy Crops
  - Biomass Sorghum
  - Sweet Sorghum
  - Tobacco

- Crop Residues
  - Corn Stover
  - Wheat Straw
  - Sugarcane Bagasse

- Woody Biomass
  - Forest Residues
  - Secondary Processing Residues
  - Short Rotation Hybrid Poplar & Willow

GENERA®

1 | Suitability

2 | Availability

3 | Practicality

4 | Reliability

5 | Cost

- Chemical and Structural Composition (lignin)
- Homogeneity (heterogeneity)
- Location
- Harvestability
- Seasonality
- Sustainability
- Scale
- Yield

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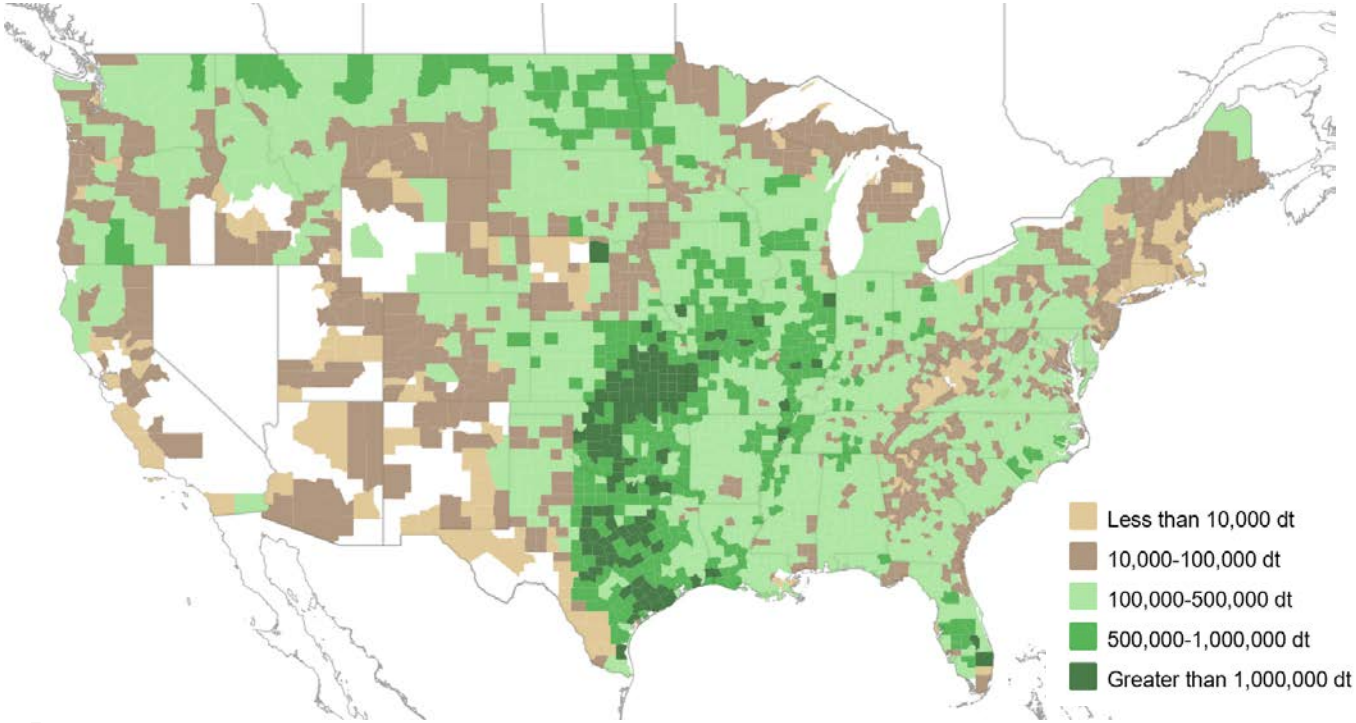
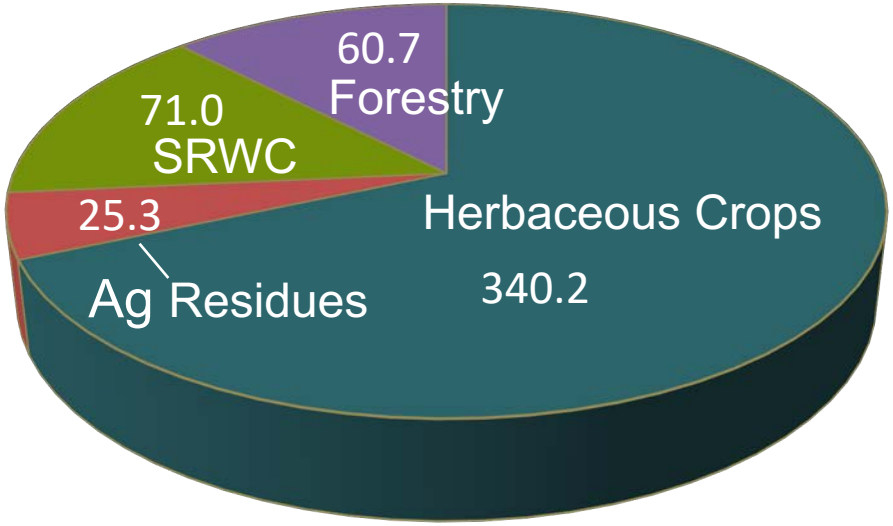
497

million DT available

- *in 20 years*
- *at $60/dt*
- *1-3% yield growth*
- *moderate housing growth*
- *moderate energy growth*





Herbaceous Crops

- *Switchgrass*
- *Miscanthus*
- *Biomass Sorghum*

Short Rotation Woody Crops

- *Poplar*
- *Willow*
- *Eucalyptus*

Agricultural Residues

- *Wheat Straw*
- *Other Straws (Barley, Oat, Rye)*
- *Sugarcane Bagasse*

Forestry

- *Hardwood*
- *Softwood*
- *Mixed Wood*

Source: U.S. Department of Energy. 2016. 2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks. M.H. Langholtz, B.J. Stokes, and L.M. Eaton (Leads), ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p. Doi: 10.2172/1271651.

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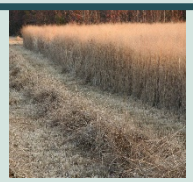
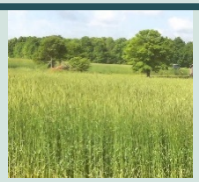
Feedstock Considerations






Switchgrass

- High yield (6-8 tons/ac) perennial grass
- Drought tolerant native species
- One annual harvest, Nov – Feb
- Grows well on low productivity soils
- Minimal management requirements

Biomass Sorghum

- High yield (7-12 tons/ac) annual crop
- Drought resistant, highly adapted
- One annual harvest, Aug – Oct
- Good fiber quality, in 15'-20' stalks
- Low chemical use vs. other row crops

Wheat Straw

- Secondary post harvest residue
- Also winter cover crop
- Yields 1.5 - 2.5 tons/acre
- One annual harvest, May – June
- Works well in crop rotations

Long-Fiber Annual Crops

- Limited scale production today
- One annual harvest
- Yields are highly variable
- One annual harvest, Aug – Oct
- Potential fractionation vaolorization

Supply Chain

- Acreage / yields
- Bulk density
- Seasonality
- Equipment
- Land use competition
- Familiarity
- Risk

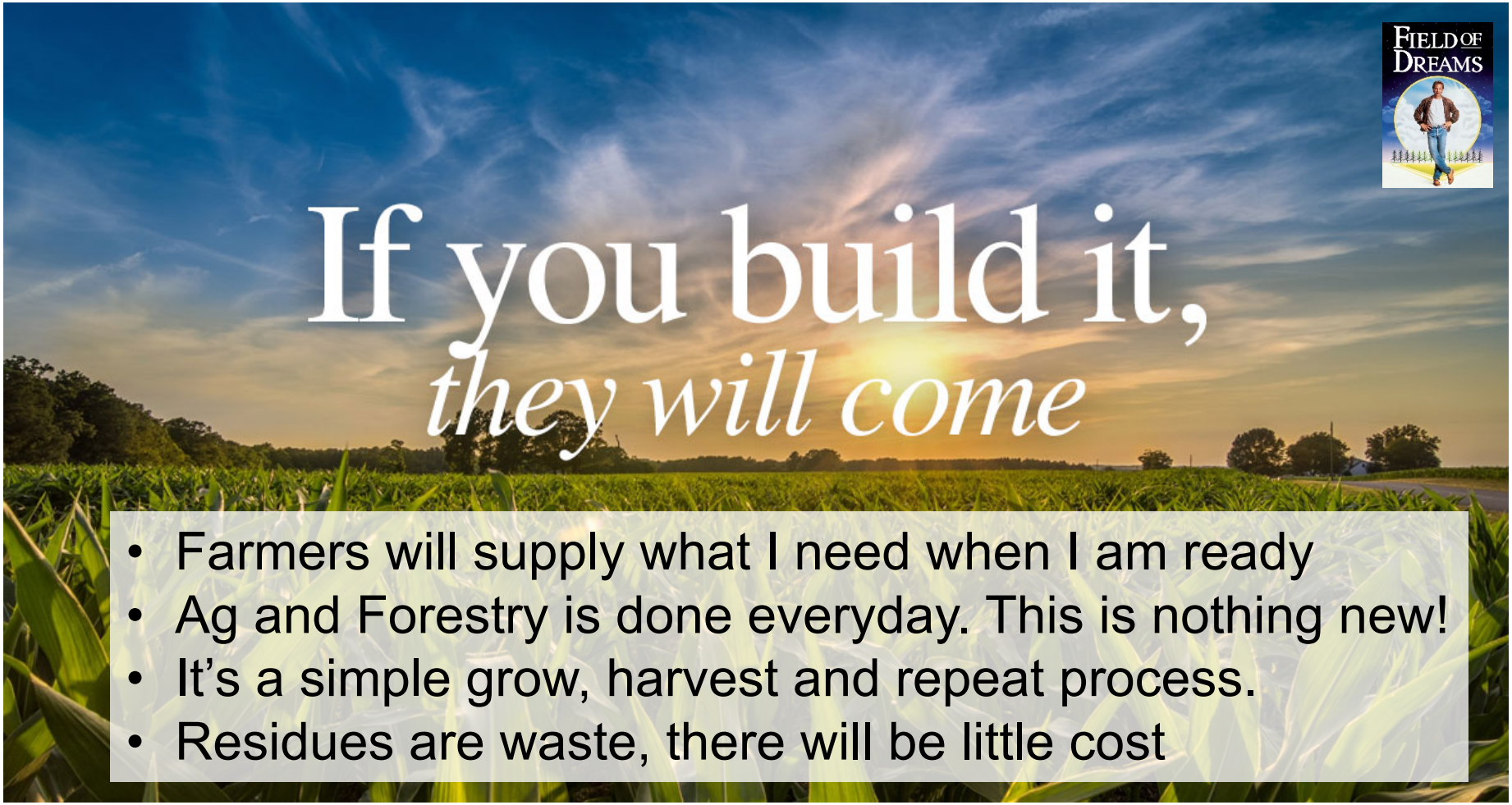
Convertability

- Process yield
- Compositional content
- Processability
- Material handling
- Silica, elementals

Sustainability

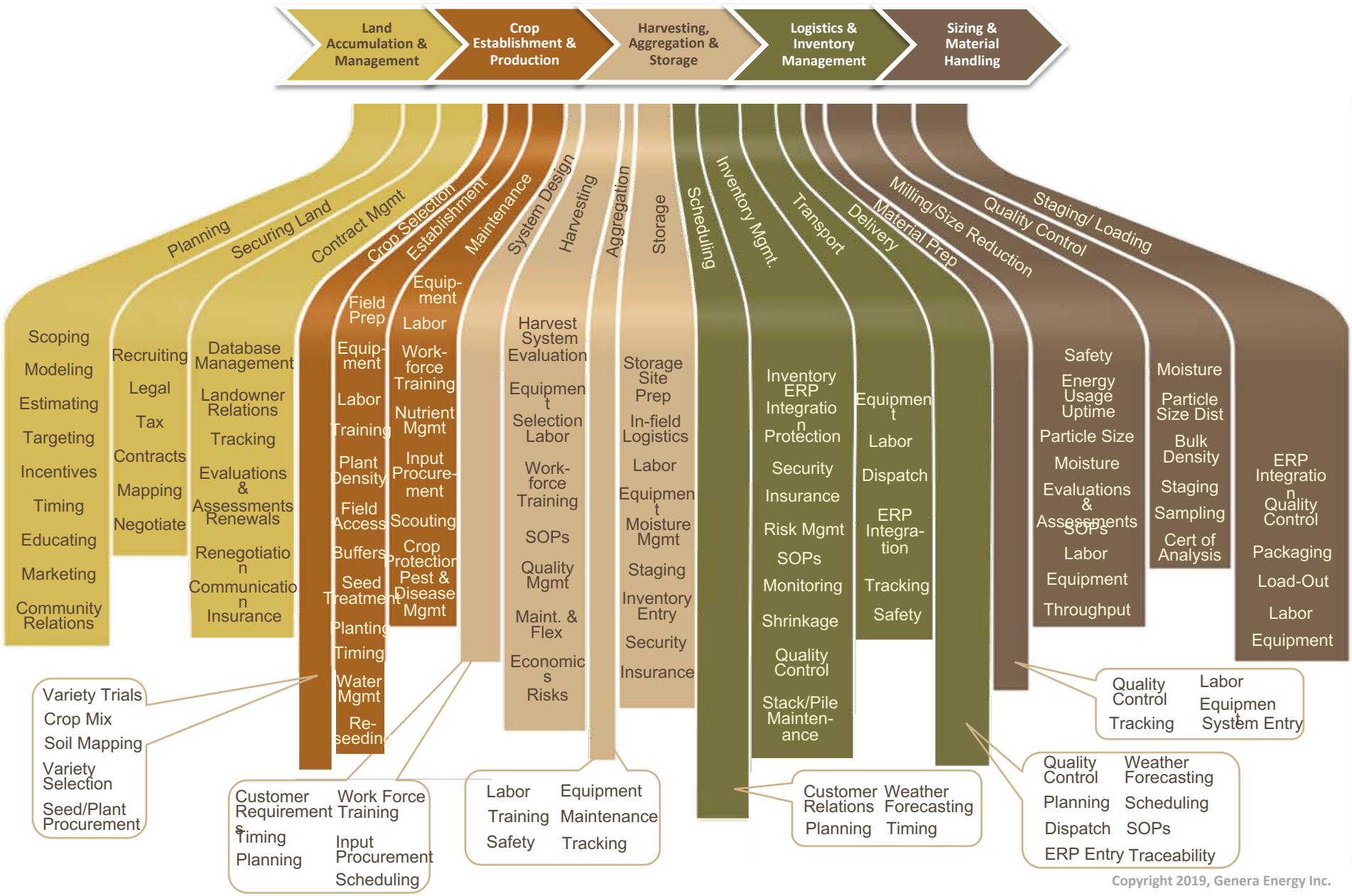
- Land use
- CO2 footprint
- Water intensity
- Chemical usage
- Energy intensity

Unrealistic Expectations!



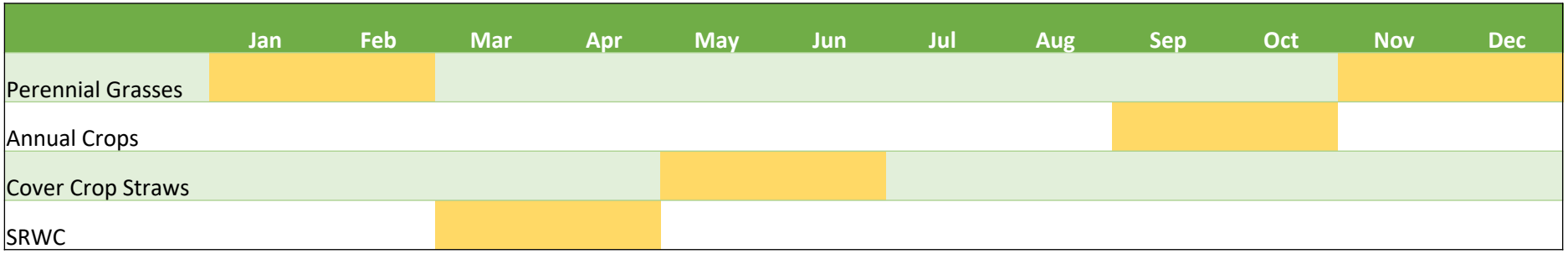
- Farmers will supply what I need when I am ready
- Ag and Forestry is done everyday. This is nothing new!
- It's a simple grow, harvest and repeat process.
- Residues are waste, there will be little cost

Supply Chain Complexity



Portfolio Approach

- Overall, a more robust supply chain
- Allows within-year adjustment of production and supply
- Buffers against climatic and disease/pest impacts
- Allows management of storage losses and degradation
- Distributes risk
- Competitive tension promotes market pricing
- Tailored pulp performance / characteristics with blending



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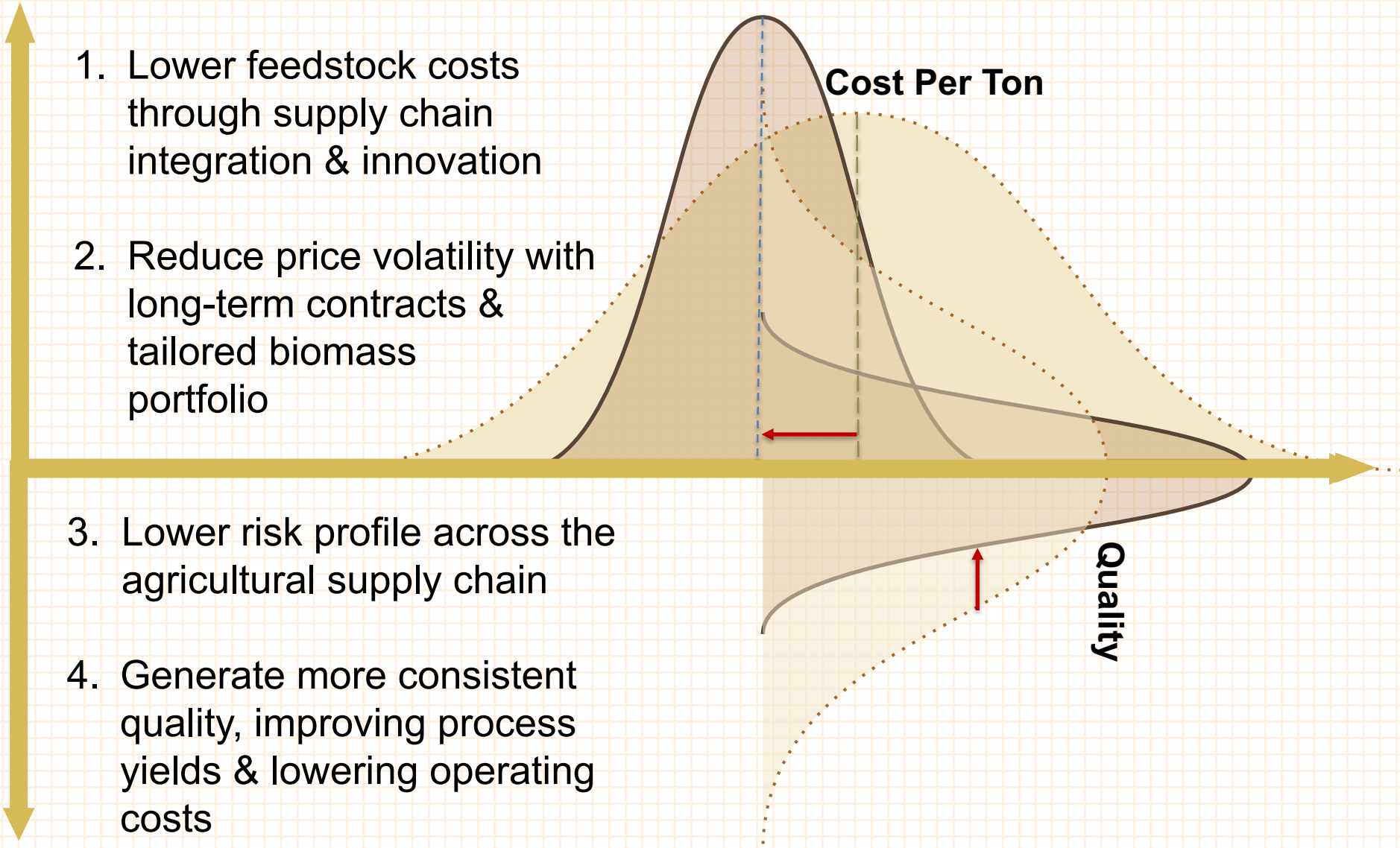
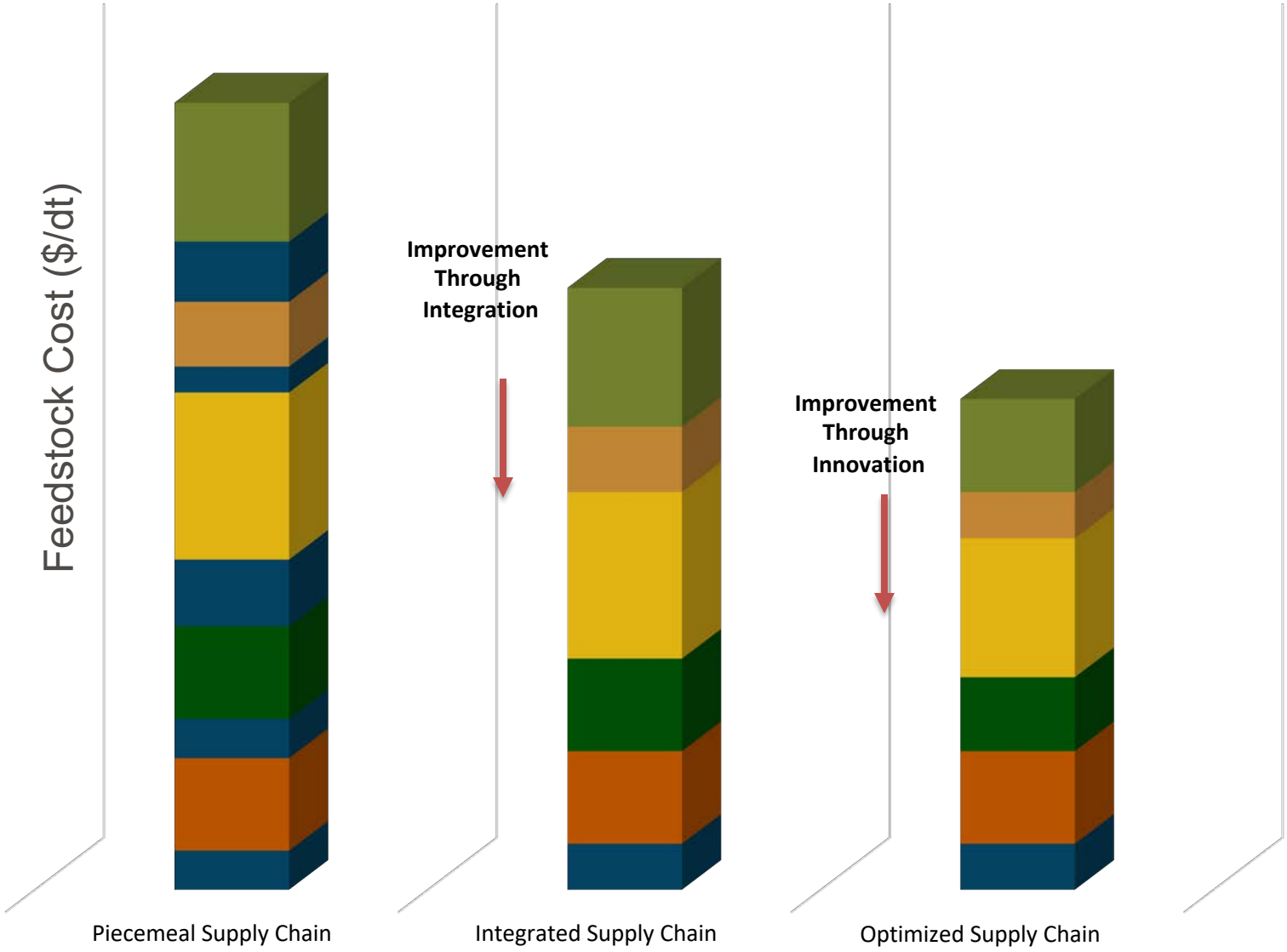
Multi-Dimensional Supply Chain Optimization

1. Lower feedstock costs through supply chain integration & innovation
2. Reduce price volatility with long-term contracts & tailored biomass portfolio
3. Lower risk profile across the agricultural supply chain
4. Generate more consistent quality, improving process yields & lowering operating costs

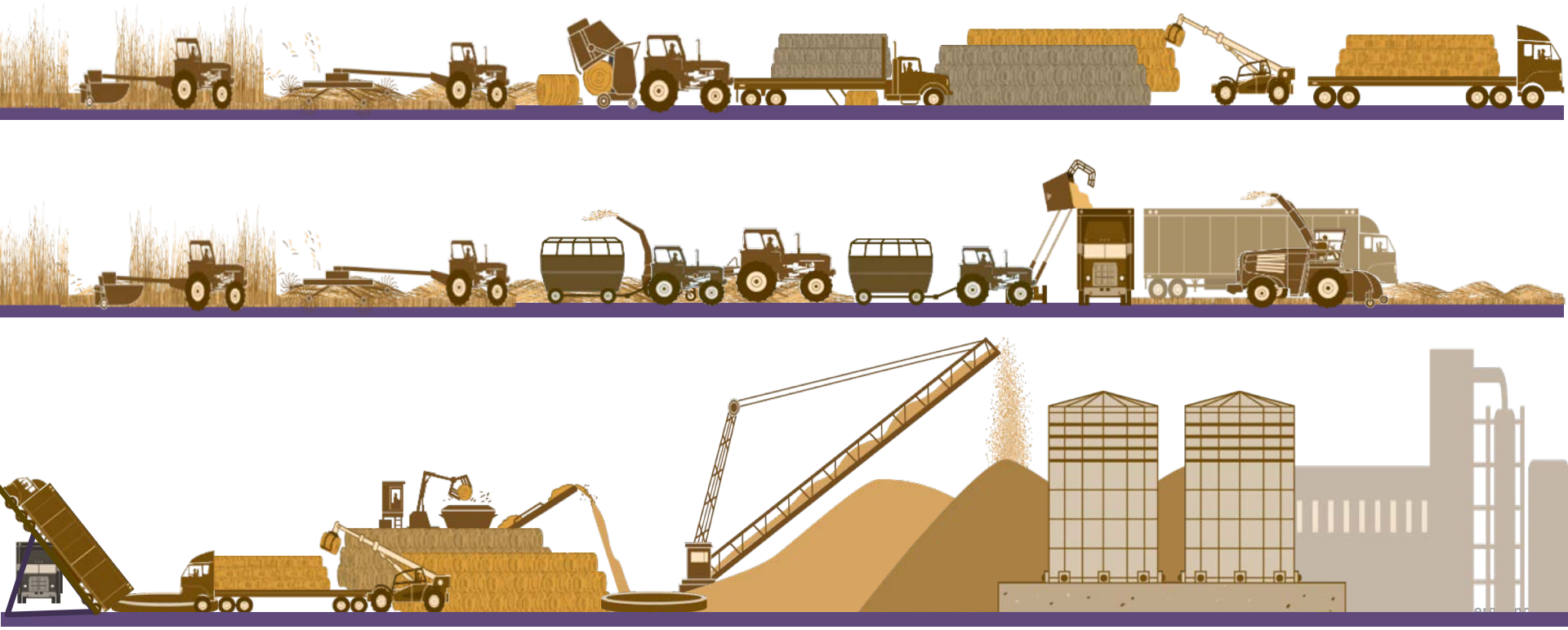


Cost Reduction Opportunities



Operational Cost Advantages & Opportunities

- Predictable costs
- Long-term supply contracts
- Fungible feedstocks = redundancy
- Year-round just-in-time supply
- Clean, consistent feedstock stream
- Cost effective buffer stock solutions
- Fractionation into constituent components
- Tailoring feedstocks to process or application



Lessons Learned

- There are no fairy tale feedstocks
- Feedstocks are expensive
- There's no such thing as a waste feedstock
- Predictability and reliability are critical
- Designing around feedstocks is actually much more effective—and cheaper—than redesigning to accommodate feedstocks

Even good feedstocks can behave badly… and they will if left to chance

DO NOT START HERE

- Invasiveness potential
- High cost of establishment
- Specialized equipment
- Minimal experience at scale
- Limited risk management tools
- Dependence on incentives

Successful Feedstock Supply Chains….

- Are carefully planned and orchestrated
- Are suited to:
  - The geography
  - The technology
  - The existing ag economy
- Manage:
  - Risk
  - Cost
  - Quality
- Lead to:
  - Farmer success
  - Production facility success

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