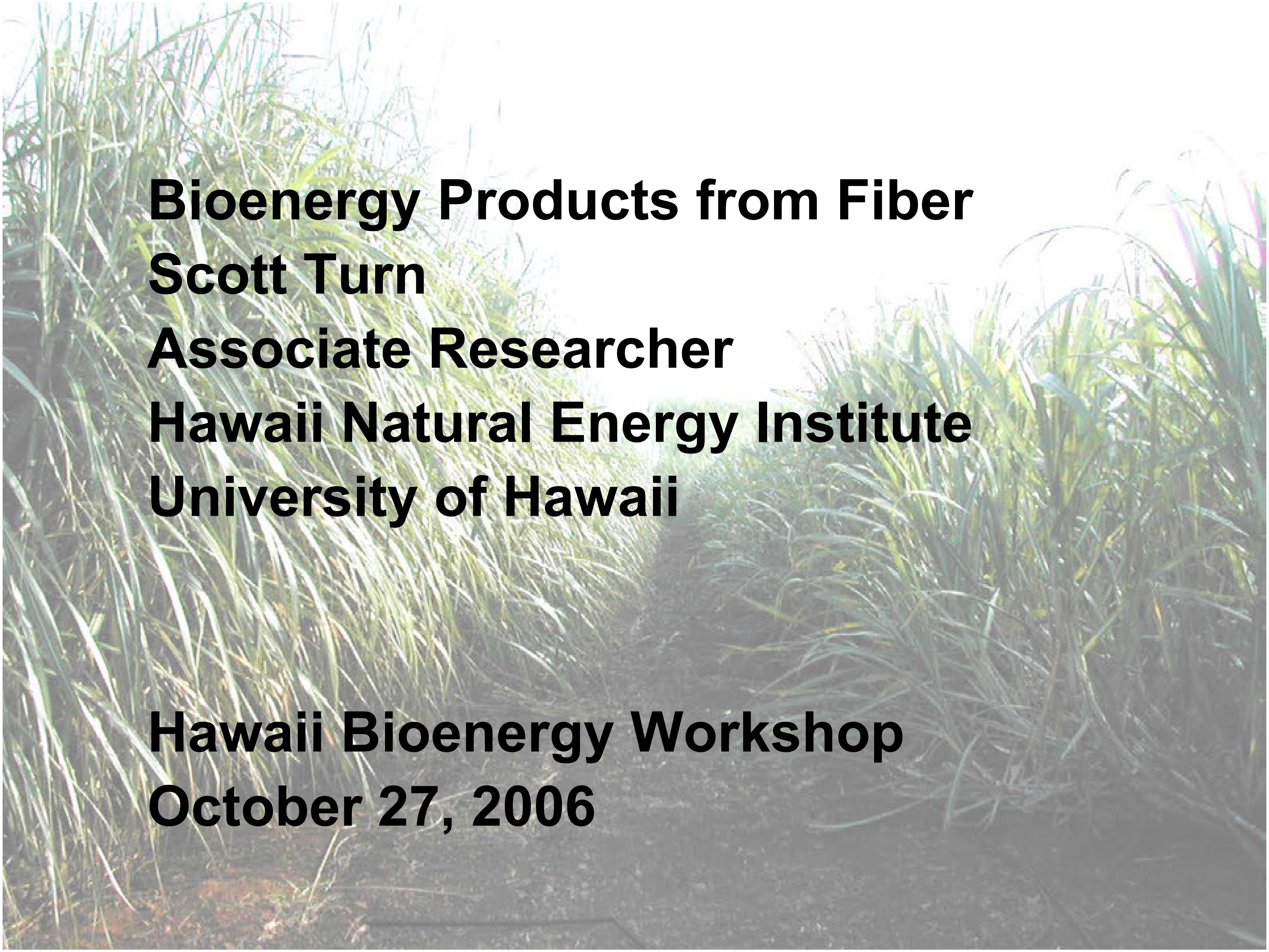

Bioenergy Products from Fiber

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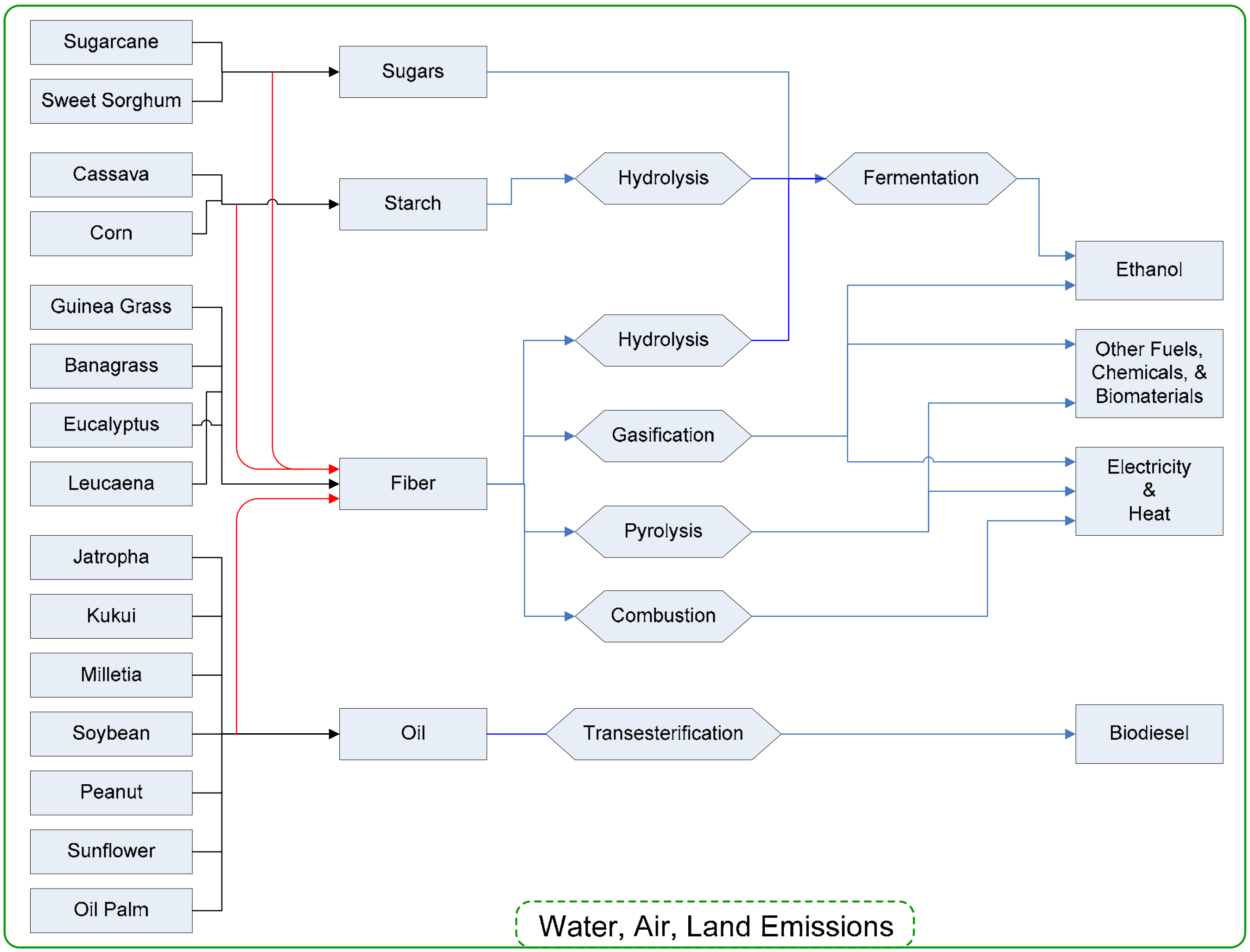
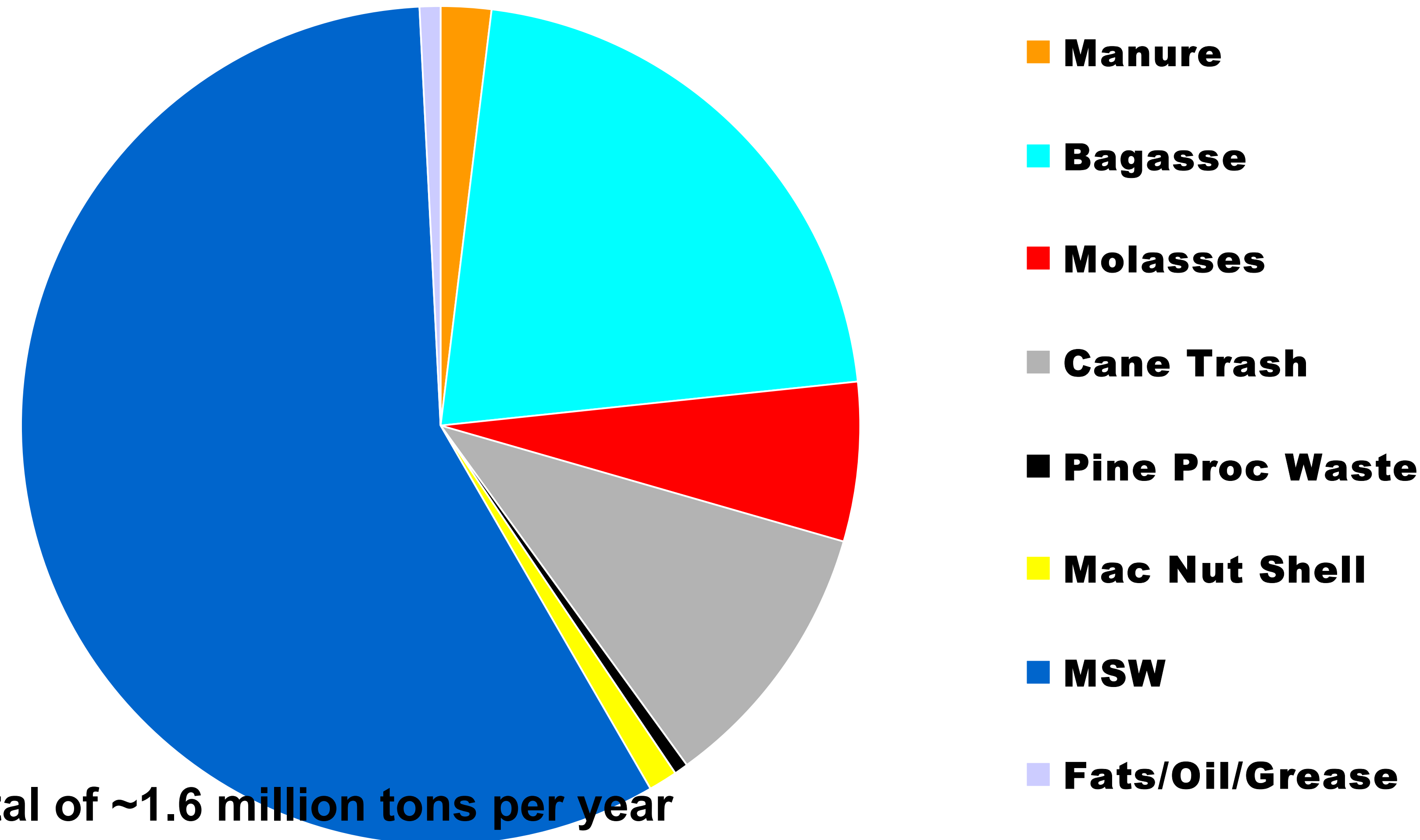
Hawaii Bioenergy Workshop
October 27, 2006

Flowchart of Potential Bioenergy Pathways



Biomass Resources in Hawaii



Total of ~1.6 million tons per year

http://www.hawaii.gov/dbedt/info/energy/publications/biomass-assessment.html

Short Rotation Woody Crops (SRWC)

- **Giant Leucaena**
  - Koa haole K8
  - Nitrogen fixing
  - Water Requirement ~50” per year
  - Harvest on four year rotation
  - Yield estimates of 13 dry tons per acre per year
- Resources: Publications by Jim Brewbaker, CTAHR

- **Eucalypts**
  - *E. grandis, E. saligna*
  - Nitrogen required with yield increases up to 520 lb/acre
  - Rainfed – 40 to 250” per year
  - Harvest on 6 to 7 year rotations
  - Yield estimates of 9 to 12 tons per acre per year
- Resources: Publications from 1970-80’s by the Bioenergy Development Corp./C. Brewer

Harvesting Grasses or Short Rotation Woody Crops (<3” DBH)

Cane harvester

CLAAS 1400, 2000

Forage harvester

CLAAS Jaguar 880

Photos: Lee Jakeway, HC&S

SWRC Harvesting: Operations & Equipment

- **Fell/Bunch**
  - Feller/buncher
  - Chainsaw w/ bunching
- **Delimb/Debark**
  - In-field
  - Landing based
- **Forward to Land**
  - Forwarder
  - Grapple skidder
- **Chip**
  - Mobile in-field chipper
  - Landing-based chipper
- **Road transport**

Conversion Options

- Biochemical
  - Fiber hydrolysis to sugars followed by fermentation to *ethanol,* pilot scale
- Thermochemical
  - Pyrolysis to produce bio-oil for subsequent conversion/refinement to *fuels, chemicals, or power* OR *biocarbon/charcoal*
    - ~1100ºF, no or very little oxygen, demonstration phase
    - Advantages: increased density for transportation, greater power generation efficiency, greater number of potential end uses
  - Gasification to produce gaseous fuel for subsequent conversion/refinement to *fuels, chemicals, or power*
    - 1500ºF, 30% of O_2 required for combustion, demonstration for heat and power, pilot scale for synfuel production from fiber
    - Advantages: greater power generation efficiency, greater number of potential end uses
  - Combustion to generate steam for *power*
    - 2000ºF, excess air for complete combustion, mature technology

Major Unknowns/Bottlenecks

- Establishment of fuel quality standards (e.g. ash chemistry) to meet requirements of pyrolysis and gasification technologies
- Establishment of fuel processing techniques to deliver fuels that meet standards
- Verification of technology at demonstration and commercial scales
- Development of gas cleaning technologies that allow utilization in gas turbines, fuel cells, etc.