Crop Genetics and Breeding Research Unit – Tifton, GA

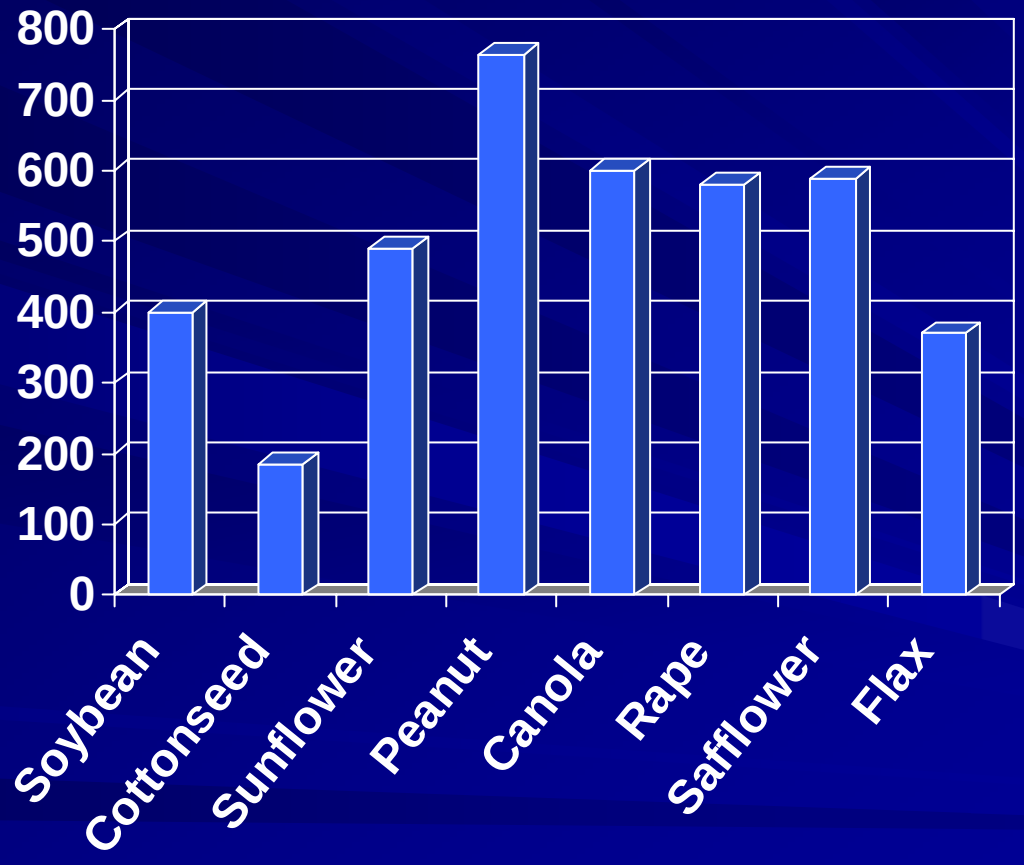
Crop Improvement for Bio-fuels

Bio-diesel feedstocks

- Oil-seed crops
  - Soybean (18 – 22% oil)
  - Cotton seed (18 – 22% oil)
  - Canola (38 – 45% oil)
  - **Peanut (46 – 48% oil)**
    - **Dr. Corley Holbrook (Peanut Geneticist)**
    - **Increase of oil content, (ARS – Raleigh: Sanders), disease resistance, lower cost of production (U. of Georgia), residues for forage use.**

Oil yields of Crops 1991-95 (Avg.)

Pounds of oil per acre



Avg price of oil was $2 - $3/gallon

Source: USDA, NASS, *Crop Production Summaries,* 1994-96

Ethanol from Corn

- Average yield in Georgia 1996-2005 was 113 bushels/acre (national avg. 138)
  - Aflatoxin concerns for animal feed use of DDGs
- Maize breeding research – USDA/ARS – Tifton (Krakowsky, Ni)
  - Reduce aflatoxin, fall army worm resistance, reduce input needs with higher yields

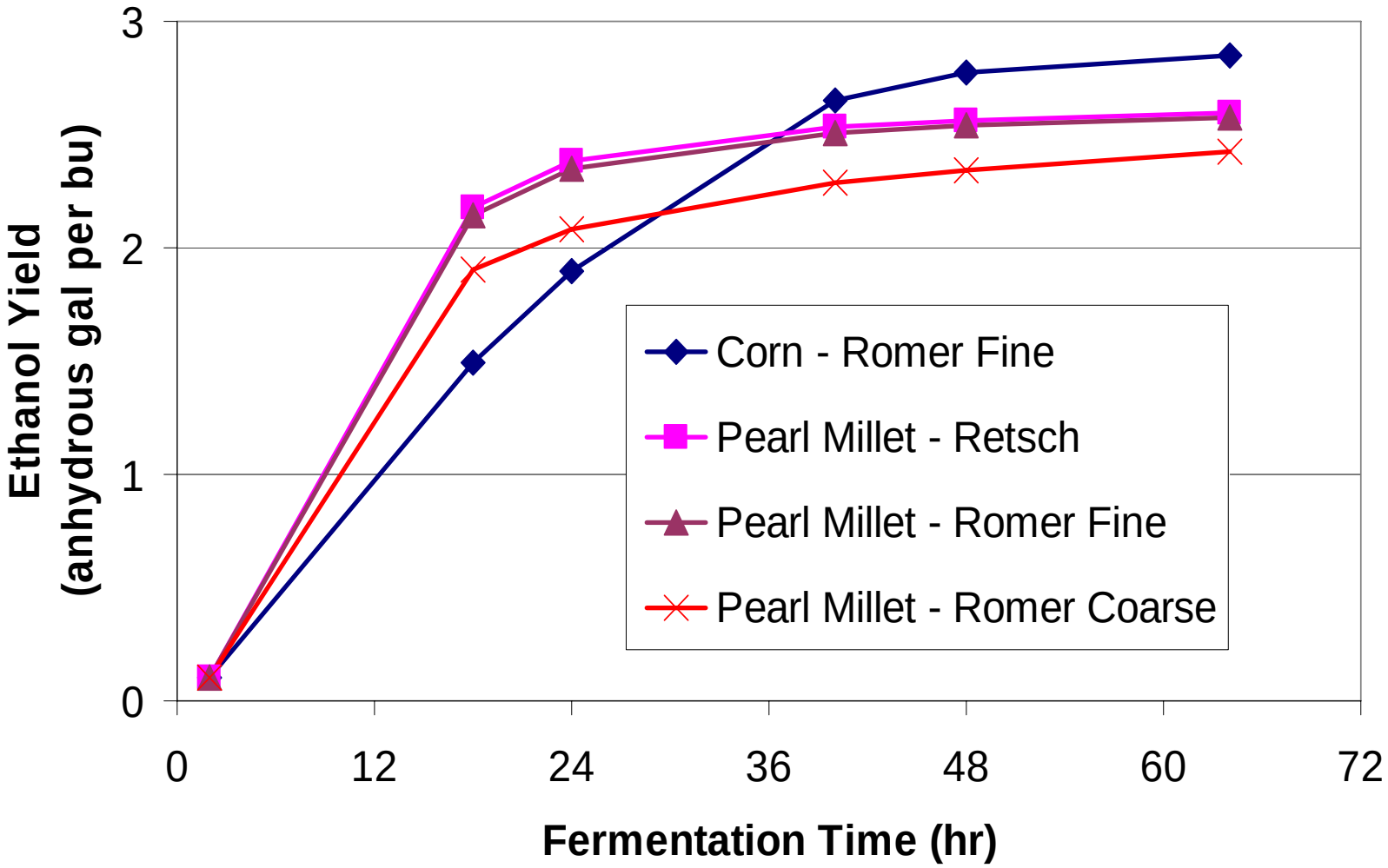
Multiple Insect Resistance

Ethanol from Pearl Millet

- Production = 1.5 – 2 tons/acre
- Very drought tolerant
- Use in double or triple cropping - low inputs and can be planted after corn
- Ethanol/ton similar to corn – faster fermentation
- DDG – higher quality – more protein
- No aflatoxin problems

USDA/ARS – Crop Breeding and Genetics Research Unit - Tifton

Ethanol Yield vs. Time



DDGS Composition (% dry basis)

	Corn	Pearl millet	Difference
Protein	26.2	30.5	+16%
Fat	10.7	16.4	+53%
Crude fiber	7.3	5.9	-19%
Ash	3.8	5.5	+45%

Ethanol Feedstocks - Cellulosic sources (Anderson, Maas)

- Bermudagrass
- Napiergrass
- Testing of perennial grass and legume feedstocks
- Annual crops – forage millet, sweet sorghum

Bermudagrass

- 600 + Forage bermudagrass PI collection
- Assessed and re-established
- Developed core collection (168 PIs) for further analysis

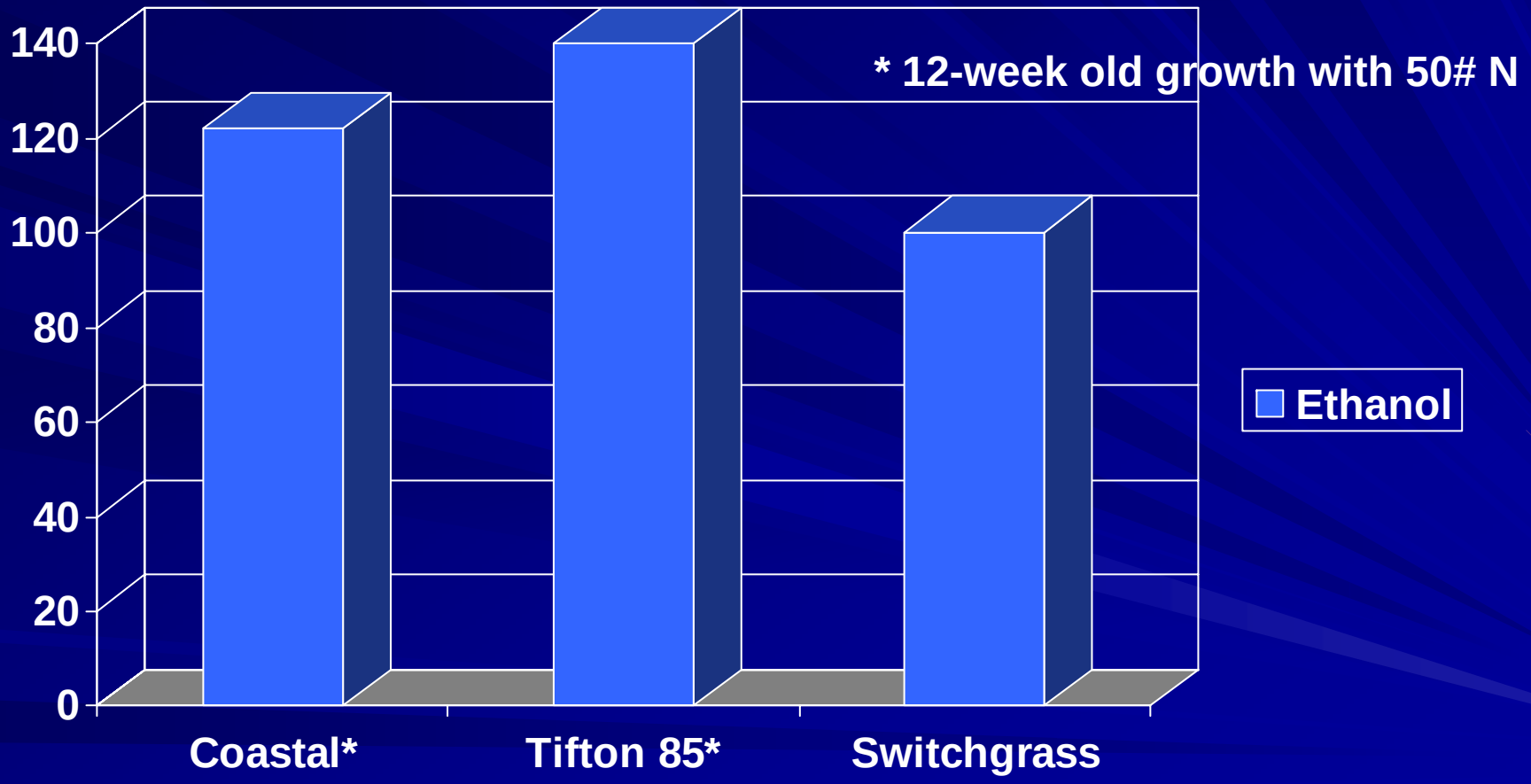
Core Assessment

- *In vitro* Dry Matter Digestibility (IVDMD), NDF, ADF, ADL, – Develop NIRS calibrations for further use (ARS – Athens RRC – Barton
- Fall armyworm resistance (ARS – Tifton - Ni)
- Genetic relatedness (AFLP) – lead to Marker-Assisted Breeding efforts
- Seed rates and viabilities

Evaluation for ethanol production

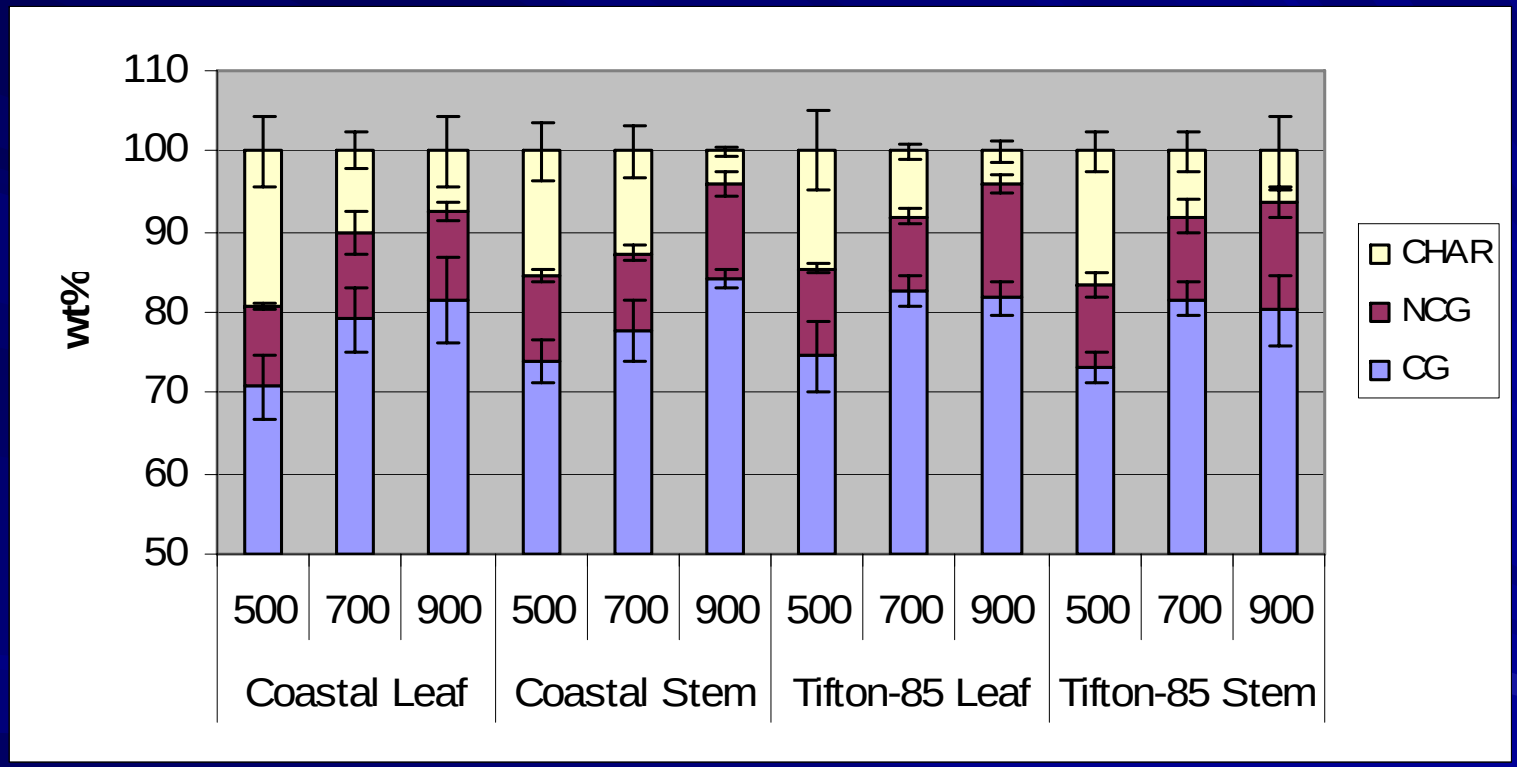
- Pre-treatments for improved conversion
  - Esterase/cellulase treatment (Athens, GA – Akin)
  - Hot water treatments (University of Georgia - Peterson)
- Evaluate diversity of germplasm for ethanol production (Peoria – Dien)
- Calibration of NIRS with traits associated with ethanol production (Athens - Barton)
- Specific cell-wall chemistry and structural traits related to recalcitrance (Athens – Himmelsbach)

Ethanol yield comparison g/kg biomass



Courtesy: USDA/ARS – Peoria IL

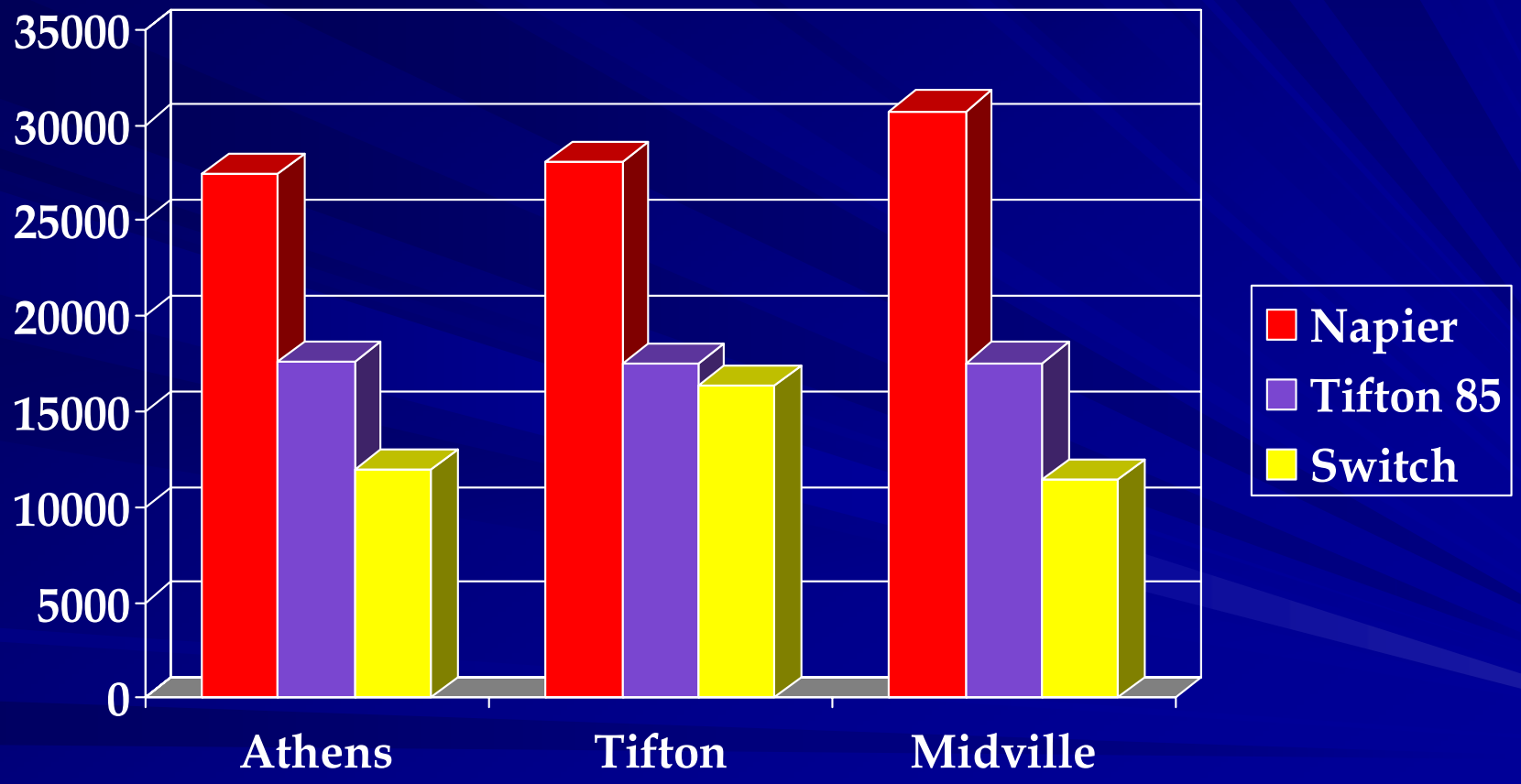
Pyrolysis of Bermudagrass – ARS – Wyndmoor (Boateng, Phillips)



Potential Dedicated Bio-energy Feedstocks

Napiergrass (Elephantgrass)

Grass Yields – 5 year average (kg/ha) 1997-2001 (J. Bouton)



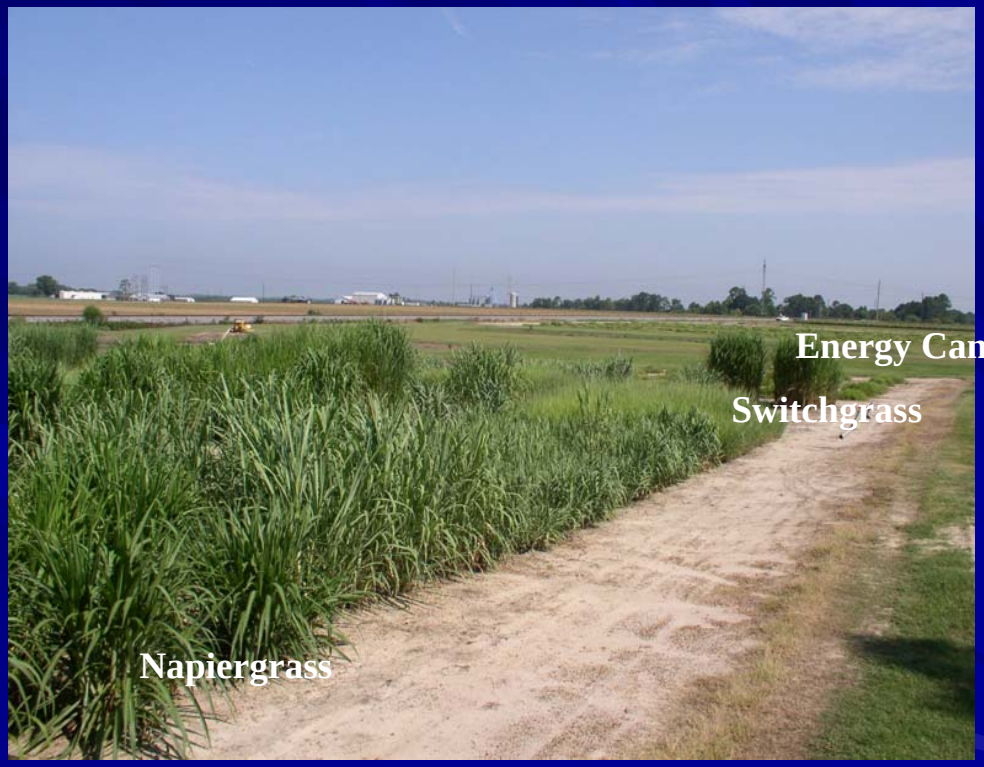
Conversion comparisons

Material	Digestibility (IVDMD%)	% Lignin (ADL)	Ethanol (g/kg DW)
Tifton 85 bermuda	50	2.9 – 4.0	140
Napier Leaf	58	2.9 – 3.2	107
Napier Stem	43	6.0 – 7.6	95
Giant Reed leaf	54	3.6 – 4.4	105
Giant Reed stem	25	8.4 – 9.9	47

Multiple Species Biomass Test

Established Oct 05

April 2006



July 2006

Biomass Test After One Year
November 22, 2006

Other ARS Units – Tifton, GA

- **USDA-ARS Southeast Watershed Research Laboratory**
  - Effects of energy crops on soil and water aspects
- **USDA-ARS Crop Protection and Management Research Unit**
  - Pest management on intensive bio-energy crop production

Future work

- Bermudagrass
  - Continue to assess variability (Genetic, chemical make-up) (ARS)
  - With high digestible lines test pretreatment enzymes, microbes (ARS and UGA – Athens)
  - Develop seeded varieties
  - Develop molecular marker assisted breeding program for stress resistance/tolerance and quality traits (UGA)
  - Develop NIR equations for degradation and chemical components (ARS)

Future work

- Napiergrass
  - Assess variability in leaf and stem chemistry
  - Perform crosses and assess progeny for yield and 5 and 6 carbon sugar releases after pretreatments
  - Genetic analysis (AFLPs) – MAS for degradable lines
- Other crops
  - Perform regional trials for dedicated biomass crops with ARS and State Cooperators