

A COUNTY-LEVEL PROGRAM TO ASSESS FARMING SYSTEM ECOSYSTEM SERVICES



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INTRODUCTION

The survival of Florida's biodiversity and economy is dependent on finding ways to balance farm economics with proper management of water and other natural resources. A two-year project entitled Hendry County Sustainable Biofuels Center (funded by U.S. Department of Energy through Hendry County Government) seeks to develop methods to maximize the delivery of ecosystems services from agricultural production systems.

Given that sea level rise is the overarching, long-term threat to south Florida and its ecosystems, the most valuable ecosystems services for the state of Florida are those that mitigate climate change. Biofuels are put forward as one approach to forestalling climate change, but its value as an industry in providing this and other ecosystem services is unproven.

The Sustainable Biofuels Center has developed a set of programs to both document and enhance the ecosystems services values of the evolving Florida biofuels industry. The Center engages in agricultural systems evaluation, sustainability indexing and sustainability research. Methods employed for documenting ecosystems services and costs include Life Cycle Assessment, Emergy Analysis, and optimization of cost-benefit functions.

Radically new farming and economic compensation systems must be created and implemented if we are to achieve a successful agricultural business model built upon balanced revenue streams from these varied services of food production and ecosystem benefits. Accordingly, the Center also supports field research and demonstration projects to document the capacity for innovative farming systems to deliver ecosystems services such as water storage.

To help promote the inclusion of ecosystems services considerations in farm operations, the program includes curriculum development at both the K-12 and college level, as well as programs to bring diverse stakeholders in to collaborative visioning process.

Lastly, since county governments are often the level where new industry seek entry to the landscape, the Center is also developing metrics and tools through which economic development officers can evaluate business developer requests for tax breaks, land use changes and various other permissions and incentives against the economic and ecological benefits as well as any natural resource costs.

Solving the underlying problems require that agricultural lands provide society with a more balanced set of values in the form of food, energy, and ecosystem services through proper water, nutrient, and soil management. County-level programs can help realize that vision.

HENDRY COUNTY'S AGRICULTURAL ECONOMY



Figure 1. Hendry County and sugarcane production areas location map.

Hendry County has a population of 39,000. In 2010, its labor force of 17,400 had an unemployment rate of 15%. Of those employed, 50% were engaged in agricultural related activities, the highest percentage of Florida's 67 counties. A full 50% of the county's population is Hispanic, and is largely employed by agriculture. Farming, ranching, and citrus have sustained the region throughout its history and during the recent economic crisis. Accordingly, any new agricultural enterprise, such as biofuels, is welcomed and encouraged by county leadership. Sugarcane, energycane, and sweet sorghum have each been the focus of attention and investment in recent years.

Sugarcane production in Florida occurs primarily on the muck (organic) soils of the Everglades Agricultural Area (EAA). However, approximately 20% of sugarcane production is on sandy (mineral) soils. The muck soils of the Everglades are more than 80% organic matter and rich in nitrogen and thus support vigorous cane growth. Compared to the organic soils, most other South Florida soils are sandy and exhibit very low organic matter content (less than 1% in the upper horizons). Both attributes contribute to their lower sugarcane productivity as well as their yield variability, which can be as high as 25% (Hanlon et al., 2005).

PROGRAM ELEMENTS

The project has established a few core objectives to promote the development and adoption of sustainable farming systems and natural resources management strategies appropriate for Hendry County and the surrounding agricultural areas of south Florida,

- (1) Provide the general public with an appreciation for the natural resources implication of biofuels production through easily understood indicators,
- (2) Develop water storage options to enhance the sustainability of farming systems for both food and biomass, &
- (3) Apply more sophisticated economic, energy, and natural resources accounting approaches to develop farming systems sustainability metrics useful to decision makers at the local as well as regional level.

To help achieve these objectives, several lines of investigation are being pursued by the project:

- LAND USE IMPACTS ASSESSMENT – by Mr. Michal Fidler, Intelligentsia International
- SUSTAINABLE FARMING SYSTEMS – by Dr. Rob Gilbert, University of Florida
- ECOSYSTEMS SERVICES VALUATION – by Ms. Kayla Oulette, Univ of South Florida
- EMERGY ANALYSIS – by Dr. Nana Amponsah, Intelligentsia International
- LIFE CYCLE ASSESSMENT – by Dr. Pepe Izursa, Intelligentsia International

The work of some of the investigators engaged in these program elements are highlighted below. Other important work in these same areas is being pursued by additional investigators, primarily based at University of Florida Institute of Food & Agricultural Sciences.

LAND USE IMPACTS OF BIOFUELS PRODUCTION

Understanding that while agricultural lands do provide valuable ecosystems services, vibrant natural lands nevertheless deliver greater ecosystem services to a region. Thus any trend that results in the elimination of prime natural areas will reduce an area's net ecosystem services output. In a world of growing population and food demand, existing agricultural lands that are allocated to biomass productions will be replaced by natural lands converted to farms or pastures somewhere on the planet. Because of differences in crop yields and biomass conversion efficiencies, differences exist between the land use demands of various bioethanol feedstocks and thus their impact upon region ecosystems services.

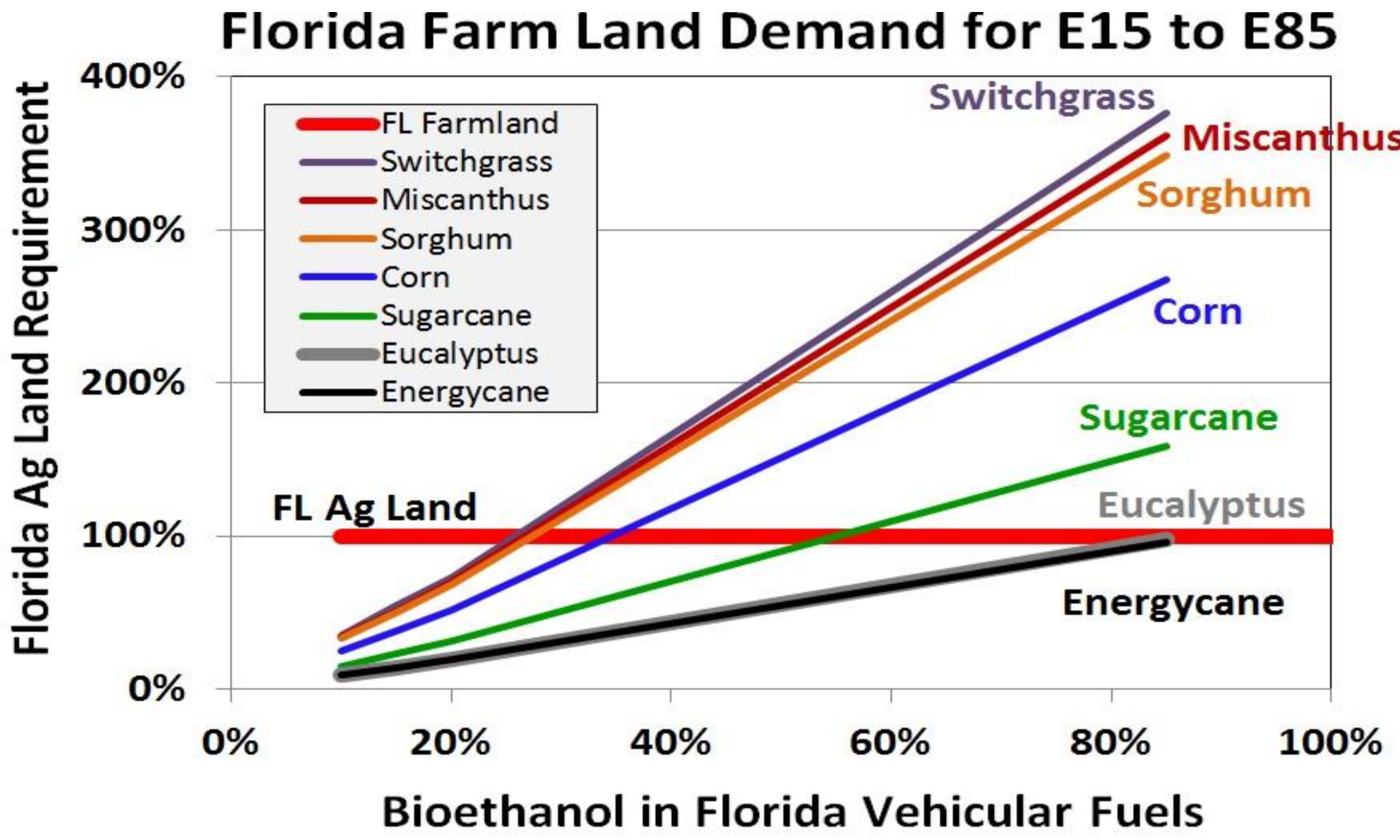


Figure 2. Land use requirements for biomass production for bioethanol in Florida.

With 19 million people, Florida consumes vehicular fuels at a rate that, if bioethanol were produced within the state, would consume all the state's agricultural land (farms plus pastures). The most efficient producers are Eucalyptus and Energycane, but even these would require 100% of agricultural to generate E85 (85% ethanol) for all Floridians. So at best, under current bioethanol production methods, biofuels for vehicular transportation constitute a one-for-one trade-off with agricultural production, with corresponding impacts upon ecosystem services production within a region.



Figure 3. Sugarcane production dominates the EAA farming region of South Florida.

EMERGY ANALYSIS

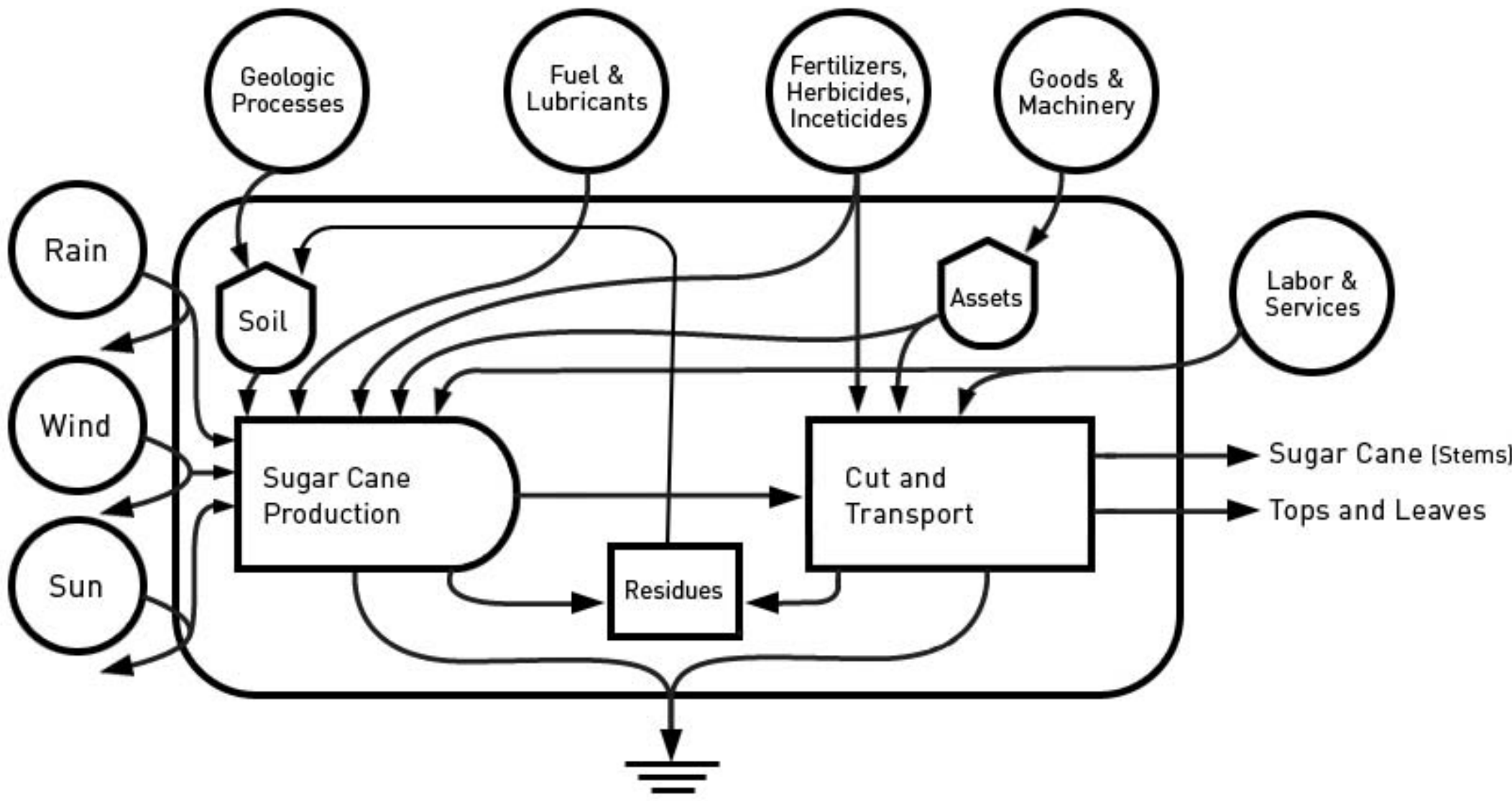


Figure 4. Typical energy systems diagram for sugarcane (Pereira and Dalbem., 2006).

Emergy is a term associated with the energy accounting protocol developed by H.T. Odum at University of Florida and used as a primary tool in Systems Ecology. Emergy is defined as the solar-equivalent energy directly and indirectly required to generate a flow or storage, whether they be objects or services, natural or manmade. The units are solar emjoules (seJ). It includes all the inputs that contributed to form the product/object or service, including environmental inputs that are regarded as "free" in traditional economic analysis. This systems approach incorporates the network of environmental, social and economic interactions. It provides a quantitative perspective on environmental costs and benefits using a common unit of measure, the solar emjoule. Thus emergy synthesis is regarded by some as the best alternative for assessing the sustainability of a production process and evaluating environmental contributions to the economy and public policy alternatives (Odum, 1995). The methodology is being applied in South Florida to determine its utility in comparing the ecosystems services merits of various farming system options. Emergy analysis characterizes a systems using energy metrics that distill all considerations down to single, easily compared values..

LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) is another accounting system being used to evaluate and compare the ecosystems services/costs of farming system options in South Florida. Unlike Emergy, it does not convert unlike quantities into common units. Instead, inputs and outputs of a system retain their original units but are distilled to specific metrics documenting production and use implications. For example, the Carbon Footprint (CFP) can be estimated from greenhouse gas (GHG) emissions (CO₂, CH₄, and N₂O) during the sugarcane cultivation.

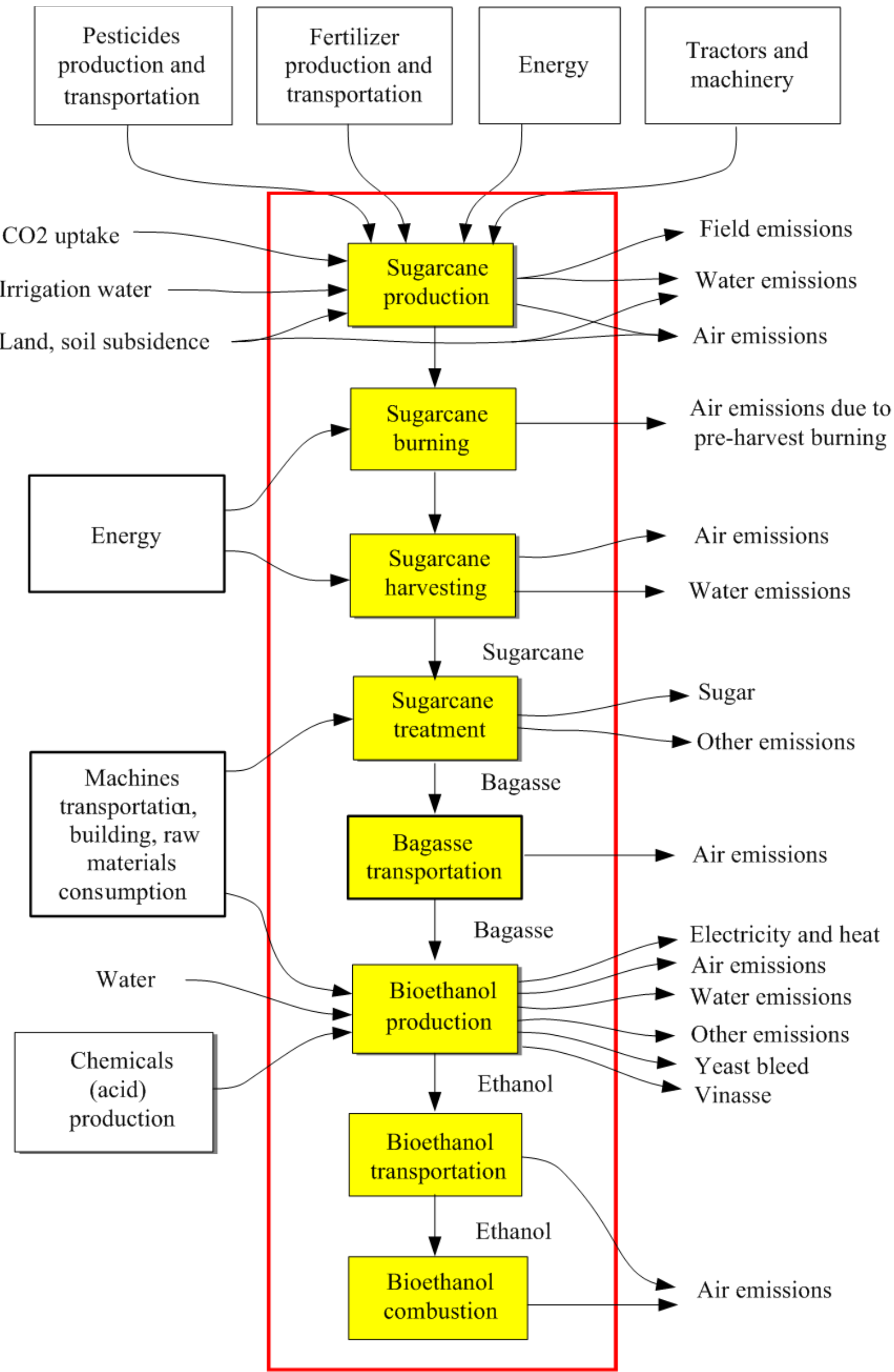


Figure 5. Sugarcane production system boundaries, processes, inputs and outputs.

SUSTAINABLE FARMING SYSTEMS DEVELOPMENT

Water storage is an ecosystems service in high demand in South Florida since it is the limiting factor in the state's ability to properly manage freshwater flows to coastal estuaries. Florida's estuaries require a balance of freshwater and ocean water to maintain the salinity dynamics that form the basis of this ecosystem. One option in delivering this ecosystem service is to maximize water storage provided by the EAA farm lands, either through the full restoration of its historical Everglades habitat or through modified farming systems that allow both sugarcane production and significant quantities of subsurface water storage. Plant breeders have identified sugarcane varieties that can tolerate wetter conditions while maintaining agronomic yields. Work continues to evaluate these as the basis for new farming systems.



Figure 6. Trials to compare the flood tolerance characteristics of sugarcane varieties.

ECOSYSTEMS SERVICES VALUATION

While new sugarcane varieties will maintain high yields under flooded conditions, current varieties do suffer yield depressions when subjected to high water tables. By combining research results that quantify crop response to high water tables with results documenting the organic soil oxidation rates under various moisture conditions, an ecosystems services model can be developed to assess long term farm economics and the corresponding agronomic-based cost of water storage. Such cost analysis constitutes one form of ecosystem services valuation.

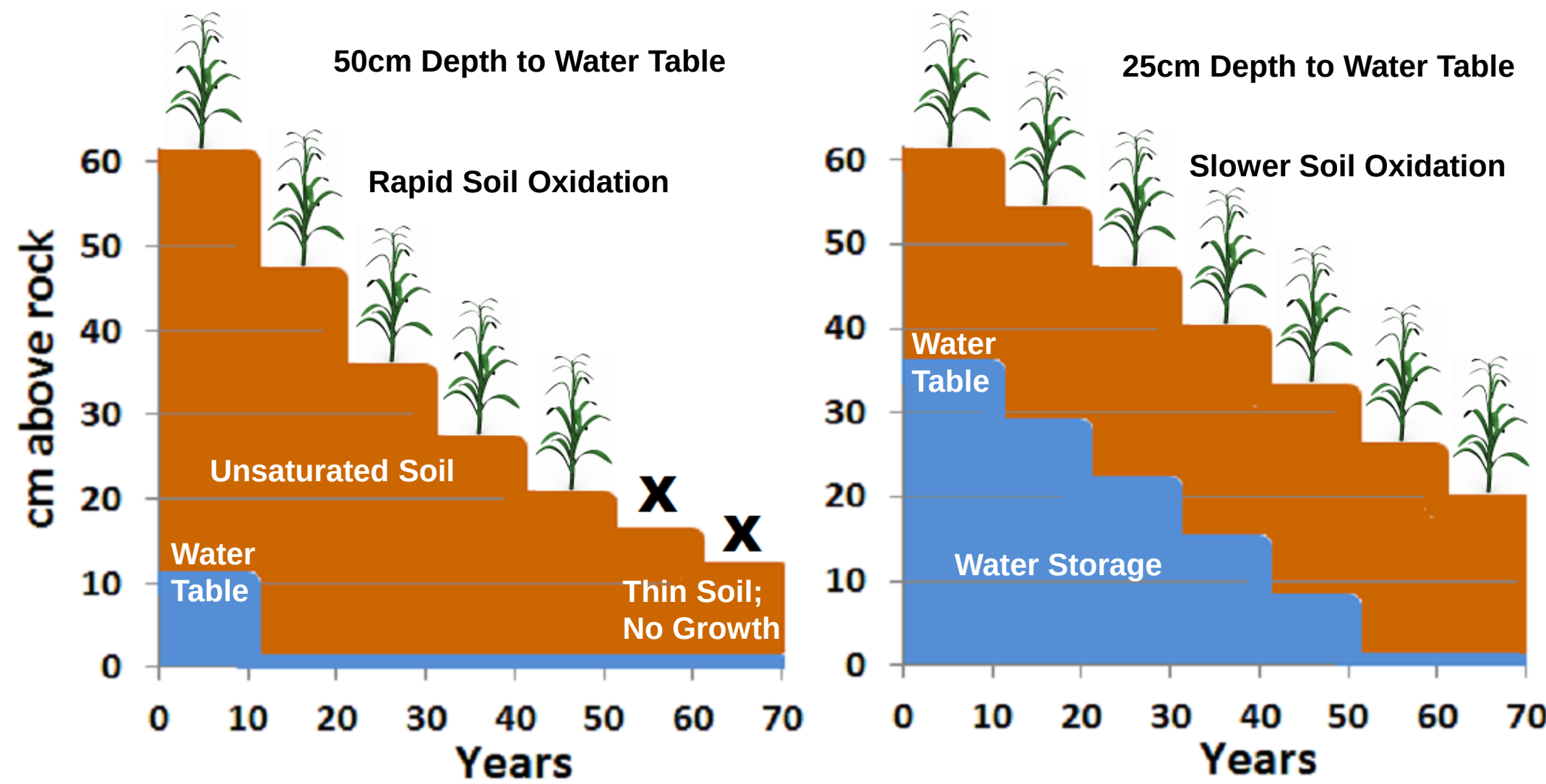


Figure 7. Soil conservation and water storage benefits of high water table management in sugarcane farms on the depleted organic soils of the EAA.

While the high water tables that allow for water storage may depress sugarcane yield under some cases, Figure 7 shows how it also slows the muck oxidation process thus slowing soil subsidence and extending the productive life span of the soil by decades. Other factors such as the reduction in carbon emissions and wildlife habitat values will be incorporated into these models to allow comprehensive, objective assessment of ecosystems services associated with modified farming system practices, such as farm water storage and the conversion to new crops or new crop varieties.

CONCLUSION

Just as the agriculture experiment stations of the land grant university system provided interdisciplinary teams to steadily improve the nation's agricultural output, modern challenges require similar teams of diverse skill sets to develop ecosystems services within each the various sectors of our economy. The results of these investigations into ecosystems services and the natural resources implications of new industries can help inform county, region and state decision makers regarding the tradeoffs (costs and benefits) of encouraging or supporting new economic initiatives such as biofuels production.

ACKNOWLEDGEMENT

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