## *3. Ethanol: Utilization of By-Products*

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Fuel ethanol production is one of the fastest growing industries in the United States. The current production of ethanol relies predominantly on starch and sugar-based material which primarily use energy crops, such as corn or sugar canes. The potential for the starch and sugar-based products as raw material for ethanol production is limited. Future expansions in the ethanol industry will ultimately need to rely on lignocellulosic substrates if significant share of the 100+ billion gallons per year of the gasoline market is to be realized. One of the major technical areas set in the Biomass R&D Act of 2000 as amended by the Energy Policy Act of 2005 is "Overcoming recalcitrance of cellulosic biomass through developing technologies for converting cellulosic biomass into intermediates that can subsequently be converted into biobased fuels and biobased products. This project is aimed at developing technologies for the conversion of cellulosic biomass to ethanol. The raw material used in this research will be the by-products from the existing ethanol industries (corn based) and use of these cellulosic materials for the production of fermentable sugars. However, the developed technology with these substrates will be equally applicable to other bio based material such as switch grass, corn stover, and other cellulosic residues.

The main focus of this research proposal is to utilize the by-products from the existing corn-based ethanol facilities, mainly DDGS and CGF. This utilization is envisioned as a refining process for these by-products which may result in a variety of marketable products including ethanol. The specific objectives are listed below:

1. Comprehensive analysis of the streams that are combined to form the by-products. This will include the beer bottom, thin stillage, steep water and corn fiber. Other streams that result from the separation steps (Objective 2) and hydrolysis steps (Objective 3) will also be analyzed and evaluated for their potential in the formulation of marketable products.
2. Separation of non-carbohydrate compounds such as lignin, oil, and protein from DDGS and corn fiber prior to or parallel with acid and enzymatic hydrolysis of the carbohydrate components of these compounds.
3. Utilization of a stage wise dilute acid and enzymatic pretreatment scheme for the hydrolysis of the refined DDGS and corn fiber streams to fermentable sugars with more than 20% sugar concentration.