Project 1.1 Emerging Feedstock Core R&D
Task 1.1.1.1 Harvesting, Collection and Preprocessing

<u>Feedstock Harvest & Collection Assembly System</u>
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Objectives: The objective of the Feedstock Harvest & Collection Assembly System task is to define emerging and innovative single-pass selective fractionation/harvest technologies and feedstock assembly infrastructure that will demonstrate an integrated feedstock supply system that reduces the overall delivered costs of biomass feedstocks from agricultural residues. The goal is to evaluate and define innovative systems, including equipment and infrastructure, that will reduce the $53/dry ton cost of delivered biomass using the present baseline baling system to a cost goal of $35/dry ton. This can be done by

a) reducing the delivered cost of the feedstock, and/or
b) increasing the quality of the delivered feedstock.

To achieve this objective, INL will work with ORNL to perform the analysis of the feasibility study data from the USDA Rural Development project in which INL participated during grain harvest in Idaho in 2004. In addition, INL will research new practices and single-pass fractionation/harvesting systems to explore improved feedstocks based on increased potential sugars. These two research activities will:

a) develop an improved feedstock assembly infrastructure (*reduced delivered cost*)
b) develop innovative single-pass selective fractionation/harvest technologies that improve the quality (potential available sugars) of the feedstock (*increased delivered quality*)

To <u>develop an improved feedstock assembly infrastructure</u>, INL will work with ORNL to assemble and organize the feedstock assembly data collected by INL in the USDA Rural Development project in a manner that it can be integrated and analyzed using the ORNL Integrated Biomass Supply Analysis and Logistics (IBSAL) model. IBSAL will be used to predict estimated costs for three different cereal straw assembly systems.

1. Scenario 1, the baseline baling system, which is the current assembly system of windrowing the straw, baling the windrow, hauling bales to fieldside, storing in a stack, transporting to the point of use, and debaling the bales for use.
2. Scenario 2, where the windrowed feedstock is collected in the field with a forage harvester, stored dry fieldside in a pile, and transported on demand to a biorefinery, and
3. Scenario 3, where the windrowed feedstock is collected in the field with a loafer, stored dry fieldside as loaves, and transported on demand to a biorefinery.

IBSAL will also be used to model and analyze the value of additional distributed preprocessing of the feedstock by grinding at one or more steps in the system, such as prior to being stored in the pile fieldside, or as the stored biomass is loaded onto trucks for transport to the biorefinery.

By using these cereal straw assembly systems as surrogate models for switch grass, data queried from switch grass research and demonstration projects (past and present projects) funded by DOE-OBP will be organized into the straw assembly system scenarios to produce a first stage integrated feedstock supply system and report for switch grass.

INL will produce a technical report summarizing the results of the first stage integrated feedstock supply system scenarios for straw and switch grass.

To <u>develop innovative single-pass selective fractionation/harvest technologies that improve the quality of the feedstock</u>, INL will also conduct field research on feedstock production and harvest, including fractionation and selective harvest of higher value biomass fractions, focused on new methods and emerging technologies that may lead to a more sugar-rich feedstock delivered to the biorefinery to optimize conversion efficiencies. This field research includes research funded by INL for a graduate student at the University of Kentucky. *(This field research is also being leveraged against DOE funded INL research on carbon sequestration.)*

Over the past two years INL has successfully assembled single-pass selective harvest systems and used them as tools to help understand the improvements that can be gained in feedstock quality by the implementation of new harvest technologies. During the 2003 harvest INL demonstrated a single-pass multi-component harvesting system that selectively harvested subcomponents of the biomass discharge from a grain combine. The purpose of this system was to demonstrate technologies that could be used to selectively fractionate and harvest subcomponents of the biomass discharge, while not requiring significant new production agriculture harvesting equipment and systems *(i.e., the biorefinery industry could start with existing on-farm equipment)*. Figure 1 shows the single-pass multi-component harvesting system assembled and used in 2003. In 2004 the INL assembled and began field-testing a system to capture separately the two discharge streams from a grain combine, the chaff stream and the straw stream. The purpose in this was to collect information on both the mass of the two streams and also their physical and chemical characteristics. The combine also logs DGPS and grain yield as well as INL biomass sensor outputs. These data are used for later analyses of the spatial variations in the mass and physical and chemical characteristics of the biomass. Figure 2 shows the two wagon harvesting system used in 2004.

Figure 1. INL single-pass multi-component harvesting system, 2003.

Figure 2. INL two wagon harvesting system, 2004.

These types of innovative single-pass selective fractionation/harvest equipment systems will be used to develop understandings of how fractionation and selective harvest of higher value biomass fractions can improve the quality of the feedstock, and thereby reduce the feedstock costs.

These systems can also be used to supply the needed pedigreed feedstocks used by other DOE biorefining platform research groups, as shown in Figures 3 and 4.

Figure 3. Feedstock collected by single-pass multi-component harvester, 2003.

Figure 4. Feedstock collected by two wagon harvest system, 2004.