Environmental and Energy Study Institute
advancing innovative solutions
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Issue Brief

Food and Crop Waste: A Valuable Biomass Feedstock

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With virtually all of the biofuels currently produced in the United States sourced from either soybeans or corn, there is significant interest in developing a diverse array of biomass feedstocks that will not compete for food resources. Dedicated energy crops such as switchgrass and hybrid poplar have caught the public's imagination, but they are not the only answer. A significant quantity of grains, fruits and vegetables produced on the nation's farms never end up on the consumer's plate, but are instead left in the field or lost in food processing facilities. These starch- and oil-rich resources can be used to produce biofuels using the same technology as the existing biofuels industry. EESI summarized data on food processing and crop waste to illustrate that unused agricultural production represents a potentially large resource. This is not meant as a comprehensive assessment; further research is needed to understand and quantify the full potential of unutilized agricultural production, particularly in light of the fact that composting firms, feed manufacturers, and other facilities currently use some of this material.

UNHARVESTED AND UNMARKETABLE PRODUCTION

It has been estimated that the average food loss rate at the farm level is 15-35% depending on the crop with total estimated losses at $25-30 billion.[i] This happens largely when yields are too low to make harvesting economically feasible. The following chart shows crop production that has been left in the field without being harvested. The values are represented in acres and not in any quantifiable volume or weight. Further studies are needed to determine the true amount of material being left in the field on a yearly basis.

Acres of land planted and left unharvested in the United States[ii]

Crop	*2005*	*2006*	*2007*	*Average*
Principal Crops[&]	13,630,200	18,650,500	15,859,900	16,046,867
Vegetables[#]	83,440	98,270	82,460	88,057
Other[$]	54,800	65,450	46,120	55,457
Total	**13,768,440**	**18,814,220**	**15,988,480**	**16,190,380**

[&] includes Corn, Sorghum, Oats, Barley, Winter Wheat, Rye, Durum Wheat, Spring Wheat, Rice, Soybeans, Peanuts, Sunflower, Dry Edible Beans, Potatoes, Canola, Proso Millet, and Sugarbeets
[#] includes Artichokes, Asparagus, Snap Beans, Broccoli, Cabbage, Cantaloupes, Carrots, Cauliflower, Celery, Sweet Corn, Cucumbers, Garlic, Honeydews, Lettuce, Onions, Bell Peppers, Chile Peppers, Pumpkins, Spinach, Squash, Tomatoes, and Watermelons
[$] includes Dry Edible Peas, Lentils, and Strawberries

The following represents unutilized production of non-citrus fruit either left unharvested or harvested but not sold. This occurs either because yields were not high enough to make harvesting economical, or fruit was damaged to the point to where it is no longer marketable.

Unutilized production of non-citrus fruit[&] in the United States (1,000 tons fresh equivalent)[iii]

2005	*2006*	*2007*	*Average*
119.5	144	53.3	**105.6**

[&] includes Apples, Apricots, Avocados, Blackberries, Blueberries, Boysenberries, Loganberries, Raspberries, Cherries, Cranberries, Dates, Figs, Grapes, Kiwifruit, Nectarines, Olives, Peaches, Pears, Plums, and Prunes

UNDERLYING CAUSES OF DECREASED YIELD AND PRODUCTION

Weather Events: Events of drought, flood, or frost can stunt growth and decrease yields to the point where harvesting fields is no longer viable. In 2007:

- Approximately $1.3 billion in damage to major field crops in the southeast was due to drought.[iv]
- $112 million in crop losses in North Carolina were due to freezing temperatures.[v]
- A decrease in orange production of 13 percent in Florida and 26 percent in California were due to weather.[vi]

Other causes such as **insect infestations** and **disease** can result in decreased crop yields or goods deemed unmarketable because of health risks or cosmetic deformities. Any factor that changes public perception about a food product may alter consumer purchasing behavior and, consequently, demand for that product.

2008 Salmonella Outbreak: In the summer of 2008, the Food and Drug Administration issued a warning about possible Salmonella contamination in tomatoes. The warning was eventually discovered to be unfounded, but a combination of precautionary measures and reduced demand by consumers affected the industry nonetheless:

- Production value losses totaled $13.9 million in Georgia ($11,778 per acre).
- 1,536 acres of tomato fields, or approximately 32% of total U.S. tomato acreage, were left unharvested.
- On an additional 9% of acreage, tomatoes were harvested and later discarded.[vii]

FOOD PROCESSING WASTE

Depending on the industry, as much as half of the harvested crop may be lost before reaching consumers.

- In the potato industry, the rule of thumb is that 50 percent of the potato goes out as finished product, while the remainder (roughly 223,403 thousand-hundredweight in 2007) is wasted. Of this waste, 30-50 percent is peel and the rest is white waste.[viii]
- In the Florida orange industry, roughly 90 percent of all oranges are harvested solely for their juice, which results in 3.5 billion pounds of dry waste annually, mostly peel and pulp, which is typically discarded. These 3.5 billion pounds are typically highly acidic and contain the enzyme limonene, which can cause significant environmental harm if landfilled or open-air dried.[ix]
- Every year, European processors produce 4.4 million tons of tomato waste; the larger U.S. tomato industry wastes even more.[x]

POTENTIAL SOLUTIONS

Recycling of waste can drive profit and reduce cost: A number of firms and industries have had great success in recycling food and crop waste, and a number of practical solutions exist. Fully developed, these mechanisms could not only decrease waste and environmental degradation, but provide cost-savings and increased profits.

- In the potato industry, new procedures exist that capture the waste as cakes of raw starch, which have resale value in the animal feed and food industries. Each 100 tons of processed potato yields 2-3 tons of starch, which has resale value of about $180 once recaptured.[xi]
- Beginning in 2005, an Archer Daniel Midland corn and soybean refining facility in Columbus, NE began a pilot program of waste and chemical recycling. After a year, the facility, which employs 285 people and processes 220,000 bushels of corn a day, recorded cost and energy savings of $107,550. This included 1 million lbs of landfill waste, 252,000 lbs of corncob waste, and 84,000 lbs of wood waste.[xii]
- Processes exist to remove up to 90% of the limonene from orange waste (at a value of $.50-$1.00/lb of limonene) before beginning enzymatic processing of the pulp to ethanol. This ethanol production process has relatively low enzymatic requirements when compared to ethanol production from corn or soybeans, costing only $.70-$.90/gallon of ethanol produced.[xiii]
- The large quantities of wastewater produced at food processing plants often hold large amounts of organic matter such as starch. By using anaerobic digestion, as opposed to traditional aeration of wastewater, a properly-equipped processing plant can capture the hydrogen and methane released during fermentation (the 'biogas'), which can be used to fuel natural gas vehicles or burned for electricity at close to 80 percent efficiency. A recent study suggests that a typical large processing plant can turn its starch-rich wastewater into hydrogen gas worth around $5 million a year.[xiv]

FINAL THOUGHTS

Unused crops and food processing wastes represent additional sources of renewable biomass that do not directly compete with food production. In addition to these upstream sources, consumers generate a large volume of downstream waste in the form of kitchen byproducts and uneaten food. According to the Environmental Protection Agency, in 2007 over 31 million tons of food waste were generated, comprising over 12% of the total municipal solid waste stream.[viii] Although there are a number of logistical difficulties with aggregating such a highly distributed resource, post-consumer food waste represents another potential opportunity for innovative energy solutions, such as production of liquid biofuels and production of biogas using anaerobic digestion. The utilization of food wastes has the potential to provide new revenue streams to crop producers and food processers while creating new sources of clean renewable energy and chemicals that do not compete with food production. This information underscores the need for new technologies to allow a diverse array of feedstocks to be utilized for biofuels production.

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