

Ethanol can be produced sustainably from the following raw materials:

1. High sugar-content materials such as sugarcane, sweet sorghum, sugar beets, or even mesquite pods
2. Starches such as cassava (manioc or yucca), potatoes, and maize
3. Cellulosic materials like wood, grasses, and agricultural residues (currently in research and development)
4. Food wastes from urban centers, such as fruit and vegetable waste from the market, processing wastes or coffee waste

Farmers in the developing world lose between 20-40% of their harvest before it ever reaches the market due to lack of electricity, cold storage, quality seeds, fertilizer, and roads suitable for transport. Gaia is helping to reduce this loss by preparing to utilize wasted fruits and vegetables to make ethanol, thus improving livelihoods and recycling this waste into energy (VOA Agriculture Report 2011)¹.

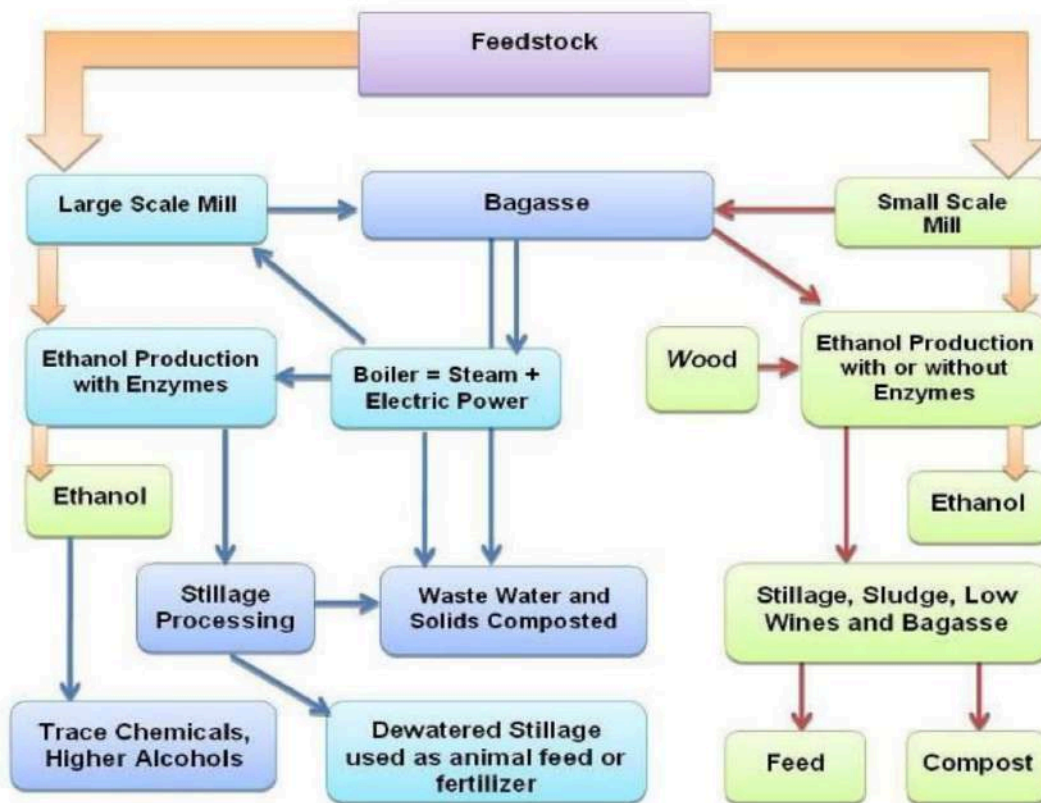
Ethanol Yield of Agricultural and Non-Agricultural Feedstocks²:

| Yield Table -- Conventional and Alternative Feedstocks | | | |
|--|-------------|------------------------------|-------------|
| | Annual L/Ha | | Annual L/Ha |
| Cattails in sewage with cellulose | 93,500 | Yams | 879 |
| Cattails (starch only) | 23,375 | Corn | 2,805 |
| Cattails wild | 10,051 | Melons (Cucurbitaceae) | 4,208 |
| Sweet Sorghum (with cellulose) | 32,725 | Buffalo gourd (Cucurbita) | 8,415 |
| Sweet Sorghum cane | 9,350 | Prickly Pear Cactus, managed | 8,415 |
| Grain Sorghum | 2,338 | Prickly Pear wild | 3,273 |
| Cassava | 16,830 | Mesquite, managed | 3,188 |
| Nipa palms (Phillipines) | 20,009 | Castor bean (Jatropha) | 3,029 |
| Nipa palm (wild) | 6,078 | Rice, rough | 1,870 |
| Sago palm (wild, New Guinea) | 6,078 | Coffee pulp | 1,403 |
| Sugar cane (22 month crop) | 8,415 | Pinapples | 729 |
| Molasses | 1,477 | Mangos | 944 |
| Tropical Sugar Beets | 5,610 | Papayas | 851 |
| Potatoes, starch only | 3,740 | Bananas | 1,477 |
| Sweet Potatoes | 2,057 | Cashew apple (India) | 486 |

Project Gaia has conducted stove pilot studies and implemented projects in countries where ethanol is produced on both large and small scales. These include Ethiopia, Brazil, Haiti and Madagascar. Project Gaia is currently in the process of introducing efficient microdistillery technology so communities can own and control their ethanol supply. Gaia believes this approach will be effective in areas suffering from extreme energy poverty, which often have great potential to produce ethanol together with food, locally.

¹Voice of America, Agriculture Report 2011

²Blume, 2007. Alcohol Can Be a Gas!



Sugarcane is one of the most efficient feedstocks for ethanol production. Ethanol can be produced from the molasses leftover after the extraction of sugarcane juice, leaving the food product untouched by fuel production. The remaining bagasse - the cellulose-rich, fibrous material left over after extraction - can be utilized in the still's boiler to generate steam and electricity to power production. Furthermore, a large part of the cost of ethanol production comes from the feedstock itself, creating a market for sugarcane farmers that would otherwise not exist.

Eventually, sugar cane may offer the additional opportunity to produce ethanol from bagasse using second-generation production, or cellulosic ethanol.

Efficient microdistilleries are simple, affordable, and versatile:

- ✓ Closing the loop between production of crops and consumption of energy.
- ✓ Using distillation co-products to heat homes, feed animals, and fertilize land.
- ✓ Allows for local production of clean fuel in both urban and rural settings.
- ✓ Allows for cheap production of clean fuel, especially in the case of sugar cane where the majority of the cost is in the feedstock itself.
- ✓ Provides a fuel that is more accessible to 'base-of-the-pyramid' buyers.
- ✓ Stimulates local agricultural markets by creating jobs in harvesting and transporting crops, operating machinery, and retailing fuel.
- ✓ Keeps wealth in the local community.

Where do families get the ethanol fuel for their stoves in Gaia Project sites?

Brazil:

1. Large-Scale Ethanol Production: Brazil is the world's second largest producer of ethanol and the world's largest exporter of ethanol. Brazil is considered the world's first sustainable biofuels economy and is the world's biofuel industry leader. Established in 1975, Brazil's Proalcool movement is a successful example of how a national movement can develop a sustainable biofuel industry, minimizing the use of fossil fuels. Throughout much of Brazil ethanol is readily available and Brazilians can fill up at the pump. Only 1.5% of Brazil's arable land is used in the production of ethanol³. Furthermore, Brazil's ethanol industry is based on sugarcane by-products and does not interrupt food supply.
2. Small-Scale Ethanol Production: In 2007, Project Gaia designed and conducted pilot studies in urban and rural areas in Minas Gerais State to assess stove reception. Households obtained ethanol from nearby pumps. Families also had the option of buying fuel directly from local microdistilleries in the community. The study yielded positive results for both the stove and fuel. Households enjoyed the benefit of being able to purchase ethanol in small quantities, an option that is unavailable to users of Liquefied Petroleum Gas. Gaia's next step in Brazil is to conduct a market study to gauge potential consumer base.

[Click here to read the Projeto Gaia Brazilian Pilot Study Final Report](#)

Ethiopia:

1. Large Scale Ethanol Production: Following a two-year ethanol interruption, Gaia has regained Ethanol supply from a new, government-owned Metahara ethanol distillery. Ethiopia's overall domestic ethanol supply increased by 250% in 2011. Excess capacity above the Government's fuel blending program is now available. The Ethiopian Ministry of Water and Energy has notified Gaia that 1.5 million liters of ethanol will be available to Gaia from Metahara for 2011.
2. Small-Scale Ethanol Production: A variety of nationwide studies were conducted with SCIP (Strategic Climate Institutions Programme), looking at policy, private market development, feedstock availability, the market, finances, and the economy. This is part of an initiative to create community-owned and operated stove and fuel projects. Gaia is also running a World-Bank-funded program to build a micro distillery in an urban community for stove fuel.

[Please see our press release with more information on the FEPA micro-distillery contract](#)

³ UNICA Sugarcane Industry Associations 2011

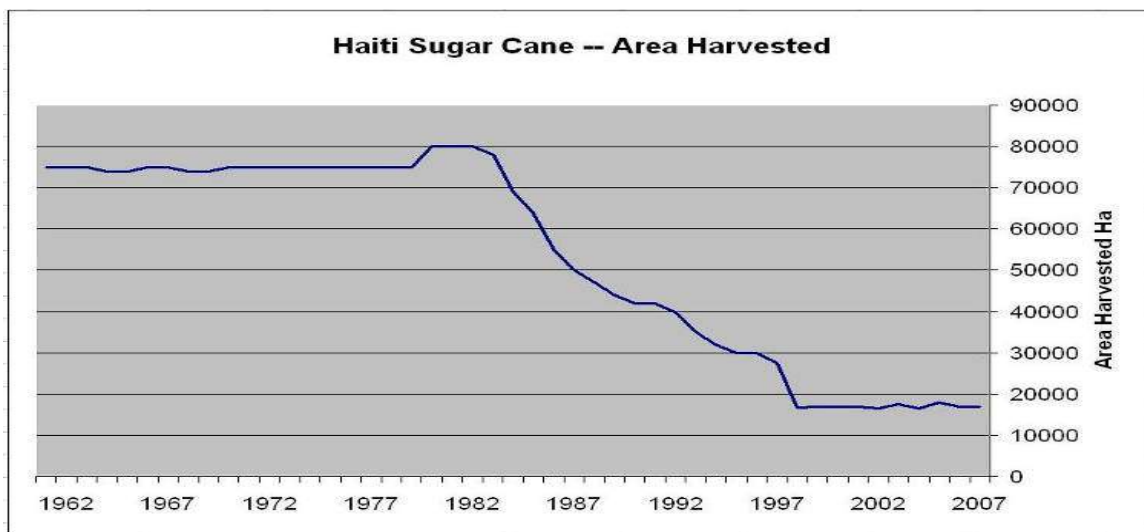
Madagascar:

Small-Scale Ethanol Production: Malagasy households received CleanCook stoves as part of a World-Bank funded study involving two pilot sites, Ambositra and Vatomandry. Each pilot site received ethanol from one dedicated micro-distillery, owned and operated by local sugarcane farmers. The stills operated at the capacity of 100-120 liters per day. Families purchased ethanol at about \$0.20 to \$0.30 cents per liter. The small-scale approach provided families an energy source that is much cheaper than kerosene and LPG and comparable to charcoal in price.

Haiti:

Project Gaia is currently under review for a grant, which will fund the construction and installation an efficient microdistillery (EMD) in Lambi, Haiti – an area west of Port-au-Prince on Haiti’s northern coast. The EMD involves simple and efficient technology that has the capacity to produce 120 liters of ethanol per day when operated eight hours daily. The EMD will be installed and operated in a 7-acre land plot owned by Grace International, a PGI partner that has worked in Haiti for over 40 years. Project Gaia will provide clean cookstoves for the planned 76 homes to be constructed on the Grace Lambi site.

During a scouting visit in June of 2010, Project Gaia identified and met with various local partners to develop a local supply of ethanol fuel for stove projects, as well as a local manufacturer of the stove body. PGI is committed to providing clean, renewable, household energy options for Haitians. Haiti, once the seat of the world’s sugar cane industry, has great potential to produce ethanol efficiently and affordably. Doing so could mean greatly reducing its energy dependence on imports of charcoal, a polluting fuel that is becoming increasingly difficult to obtain for many Haitians.



(UN Data 2009)

In 1983 Haiti fed itself and harvested 78,000 Ha of sugarcane. Today it cannot feed itself and harvests less than 17,000 Ha of cane. The food vs. fuel debate is not about local resources but global markets. If Haitian farmers can thrive again, Haiti will thrive. Producing for a local stove fuel market will be good for farmers, who will earn a living and be able to plant next year.