Maize residues as a source of energy

Energy from biomass is considered carbon-neutral because the carbon dioxide released during its use is already part of the carbon cycle. Increasing the use of biomass for energy can help to reduce the negative CO_2 impact on the environment. Including the production of biomass as a source of energy, with consequential greenhouse gas emission credits, is a method for farmers to offset the greenhouse gas emission liability that the methane from animals on a farm produces.

Maize or corn (Zea mays) can be a valuable source of energy as either a combustion fuel or as a feedstock for the production of transport fuels. Famers growing maize can use the residues (stover) or can use the full plant as a source of energy. The energy products complement normal farm activities and improve farm business resilience by providing business diversification and the production of products in different markets, thus a market risk management tool. Farmers adopting a food plus fuel business strategy shape a business to be resilient to market events[1].

Maize crop

Utilisation of maize "waste" can be a mechanism for offsetting any biological greenhouse gas emissions as if left to rot in a field or landfill the decomposition produces methane. Using the organic waste to produce carbon neutral energy could be a credit under the New Zealand Emissions Trading Scheme.

Integrated with normal farm activities

Production of solid or liquid biofuels from corn can be done in conjunction with using the corn as an animal feed as one-third of the weight and 100% of the nutritional content of corn entering an ethanol dry mill biorefinery is returned to the feed market as distillers grains. These distillers grains can be used to replace corn in the diets of cattle, pigs, and poultry.

Corn responds best to highly fertile soils with supplemental fertilizer applied in most years. If grown on a dairy farm the corn can benefit from bio-fertiliser produced from anaerobic digestion of dairy shed and standoff pad effluent.

For farmers, harvesting stover means reaping more value from their crops.

Combustion of harvest residues

Harvested corn stover can be used for direct combustion to produce heat in standard boilers designed for wood logs[2].

[1] https://farm-energy.extension.org/corn-for-biofuel-production/

[2] R Morissette, P Savoie and J Villeneuve 'Combustion of Corn Stover Bales in a Small 146-kW Boiler' Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Quebec City,

Stover with a very low moisture content (6.83 ± 0.17%), will have a gross calorific value (GCV) of 18.57 MJ/kg of dry matter (±0.32 MJ/kg DM) and an ash content of 5.88% (±1.15%). The stover needs to be processed into small pieces or pelletised in order to be distributed around a heat plant site and transferred into the boiler. The overall heat transfer efficiency for stover is lower than for wood (57% vs. 77%). The corn stover shows a good calorific potential, but it would have to be densified and the boiler should be modified to improve airflow, completeness of combustion and handling of the large amount of ash formed.

Baled corn stover for biofuel production

Some specially designed boilers will allow the stover to be in small bales for acceptance as fuel.

There are many challenges in using biomass for energy applications, such as low bulk density, high moisture content, irregular size and shape, hydrophilic nature, and low calorific value. In commercial scale operations where large quantities of biomass are needed, these limitations will create problems associated with storage and transportation. Furthermore, grinding raw biomass with high moisture content is very challenging as there is no specific equipment, which can increase costs, and in some cases becomes highly impossible. All of these drawbacks have led to the development of some pretreatment techniques to make biomass more suitable for fuel applications. One of these is torrefaction. Torrefaction is the heating of biomass in an inert or reduced oxygen environment. During torrefaction, biomass losses moisture, becomes more brittle, and increases energy density values[3]. Torrefied biomass fuel can be left out in the rain and it wont absorb moisture. It is an ideal replacement fuel for use in existing coal fuelled boilers.

Processing corn stover into pellets so that a smooth, dense and hard fuel is produced can be done in a corn stover pellet mill. The stover is compressed into biomass pellets that can be burned like coal in existing heat plants, reducing CO_2 emissions and increasing renewable energy supplies. With modest infrastructure investments, building even a single pellet facility can deliver large quantifiable economic benefits across farm economies. Developing a broader industry around corn stover represents a multi-billion dollar opportunity. This is of particular value in areas where there is a shortage of forest wood available as fuel.

Some regions within New Zealand are experiencing shortages of wood derived biomass fuel. In these regions farmers should be looking to fill the supply gap as the demand for use of renewable fuel for process heat is increasing as Government advocated for 100% coal replacement. Farmers in those regions should look to establishing local biomass fuel supply cooperatives.

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https://www.researchgate.net/publication/265097267_Combustion_of_Corn_Stover_Bales_in_a_Small_146-kW_Boiler

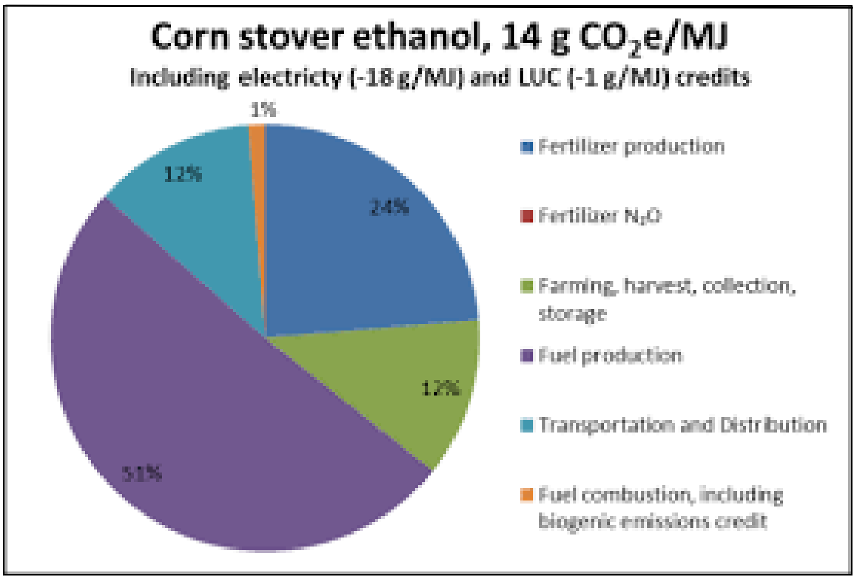
[3] J Tumuluru, T Kremer, C Wright, and R Boardman. *'Proximate and Ultimate Compositional Changes in Corn Stover during Torrrefaction using Thermogravimetric Analyzer and Microwaves'*, Idaho National Laboratory, https://inldigitallibrary.inl.gov/sites/sti/sti/5517250.pdf

Production of ethanol

Corn is a popular feedstock for ethanol production in the United States due to its abundance and relative ease of conversion to ethyl alcohol (ethanol). Corn and other high-starch grains have been converted into ethanol for thousands of years, yet only in the past century has its use as fuel greatly expanded. Conversion includes grinding, cooking with enzymes, fermentation with yeast, and distillation to remove water. For fuel ethanol, two more steps are included: using a molecular sieve to remove the last of the water and denaturing to make the ethanol undrinkable.

Corn grain makes a good biofuel feedstock due to its starch content and its comparatively easy conversion to ethanol. Infrastructure to plant, harvest, and store corn in mass quantities benefits the corn ethanol industry. Unlike sugarcane, in which squeezed sugar water can be directly fermented, corn starch must be cooked with alpha and gluco-amylase enzymes to convert the starch to simple sugars. Cellulosic feedstocks such as pinus radiata are even more recalcitrant and require time and energy to convert to simple sugars.

Life cycle analysis (LCA) of ethanol production from corn grain has yielded a net energy ratio of 1.2 to 1.45[4], which represents just a 20% to 45% positive energy balance in producing ethanol from corn. A major criticism of corn ethanol has been the large amount of fossil energy used in production.



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