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Co-generation of energy and feed / food in integrated farming systems for socio-economic and environmental benefits

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Abstract

Two experiments were carried out to estimate the potential of inedible biomass residues of four selected crops (cassava, mulberry, coconut and cassia stamea) as feedstock in a gasifier to produce electricity. The efficiency of conversion, from solid form of edible fibrous biomass into fuel (producer gas), using as internal combustible gas for generator, was determined.

Experiment 1: The fibrous wastes were coconut shell-husk, woody stems of cassava, mulberry stems, and the branches from the fast growing tree, *Cassia stamea.* The materials were chopped (2-4 cm length) and sun-dried to 20% or less moisture content. Three tests were done with each feedstock. The density of the feedstock was highest for the *Cassia stamea* and lowest for cassava and coconut, with an intermediate value for the mulberry. Despite these differences in feedstock density, there were no differences among sources of feedstock in the operating parameters of the gasifier (yield and conversion of feedstock to electricity, and energetic efficiency). The conversion of feedstock to electricity was in the range of 1.11 to 1.23 (kg dry biomass/kwh); energetic efficiency (MJ of electricity/MJ of biomass) was in the range of 0.19 to 0.22, compared with 0.29 for a diesel engine-generator.

Experiment 2: Surveys were carried out to determine the biomass yield of selected crops in order to estimate the potential gross income from cogeneration of energy and feed / food. The coconut crop was studied on farms in Takeo and Kompot provinces; cassava was studied on farms in Takeo and Kompong Cham provinces; mulberry and *Cassia stamea* were evaluated at CelAgrid, Kandal province. The potential for generation of electricity was estimated to be in the ranges of 4665 to 14156 kwh/ha/yr for coconuts managed for sale of green nuts for drinking; 6141 to 13936 kwh/ha/yr for mulberry managed for leaves as a protein source for livestock; 16970 kwh/ha for cassava managed for leaf and tuber production, and 1221 kwh/ha managed for leaf and human food from the roots in the low yield region; and 4120 kwh/ha/yr for *Cassia stamea* managed as a shade tree. The data derived from this survey indicate a considerable scope for adding value to the selected crops when the fibrous residues are used as feedstock for a gasifier.

Fibrous woody residues in the form of coconut husks and stems of cassava, mulberry and *Cassia stamea* are efficient and effective sources of feedstock in a downdraft gasifier. Apart from the direct economic advantages there will be associated social and environmental benefits as the technology is “carbon-neutral” (without net emissions of carbon dioxide) and will increase employment in rural areas. Renewable energy from inedible fibrous biomass residues are able to serve well in sustainable rural development.

Key words: Cassia stamea, cassava, coconut, electricity, gasification, mulberry, renewable energy, residues.