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The potential for energy production from crop residues in Zimbabwe

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ABSTRACT

There is increasing interest in Zimbabwe in the use of renewable energy sources as a means of meeting the country's energy requirements. Biomass provides 47% of the gross energy consumption in Zimbabwe. Energy can be derived from various forms of biomass using various available conversion technologies. Crop residues constitute a large part of the biomass available from the country's agriculture-based economy. The potential for energy production of crop residues is examined using data such as estimates of the quantities of the residues and their energy content. The major crops considered are maize, sugarcane, cotton, soyabeans, groundnuts, wheat, sorghum, fruits and forestry plantations. Quantities of residues are estimated from crop yields by using conversion coefficients for the various crops. Long-term crop yields data from 1970 to 1999 were used. Total annual residue yields for crops, fruits and forestry plantations are 7.805 Mt, 378 kt and 3.05 Mt, respectively. The crops, fruits and forestry residues have energy potential of 81.5, 4.9 and 44.3 PJ per year, respectively. This represents about 44% of the gross energy consumption in Zimbabwe. The need to balance use of crop residues for both energy purposes and other purposes such as animal feeding and soil fertility improvement is also highlighted.

1. Introduction

Africa accounts for about 5.5% of the world energy consumption [1] and energy demand growth in Africa averaged about 3.1% per annum between 1990 and 1997 [2]. Although Africa accounts for a small share of world commercial energy consumption, it has a large share of the world's biomass energy consumption. Most of Africa's biomass energy consumption is in sub-Saharan Africa where it accounts for 86% of total energy consumption outside South Africa [1]. Zimbabwe is one of the sub-Saharan African countries, which rely mainly on biomass for the supply of energy.

The energy sector in Zimbabwe accounts for about 15% of the GDP and a total of about 280 PJ is consumed per year [3]. Energy consumption in Zimbabwe has grown at a rate of about 3.5% per annum, often exceeding GDP growth rate [3]. Several types of energy are in use in Zimbabwe. The country's primary energy base consists of coal, thermal and hydropower, biomass and solar energy. The country imports all its petroleum-based fuels. Over 76% of the country's population relies on biomass as an energy carrier [1]. In addition, biomass accounts for about 47% of the energy supply in Zimbabwe [4]. The structure of energy supply in Zimbabwe in relation to the African continent and the world is shown in Table 1.

Data in Table 1 clearly show the importance of biomass in energy supply in Zimbabwe. The major forms of biomass available in Zimbabwe are fuelwood, animal wastes, forestry wastes, municipality wastes and crop residues. The potential of renewable energy technologies and the associated barriers in Zimbabwe have been studied [3]. A number of studies have dealt with various aspects of biomass production and bioenergy use in Zimbabwe [5–7]. However, studies have

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Table 1 – Structure of energy supply sources in Zimbabwe, Africa and the World (%)

	Energy sources				Reference
	Biomass	Electricity	Coal	Petroleum	
Zimbabwe	47	13	19	21	[4]
Africa	59	8	4	25	[1]
World	14	16	7	44	[1]

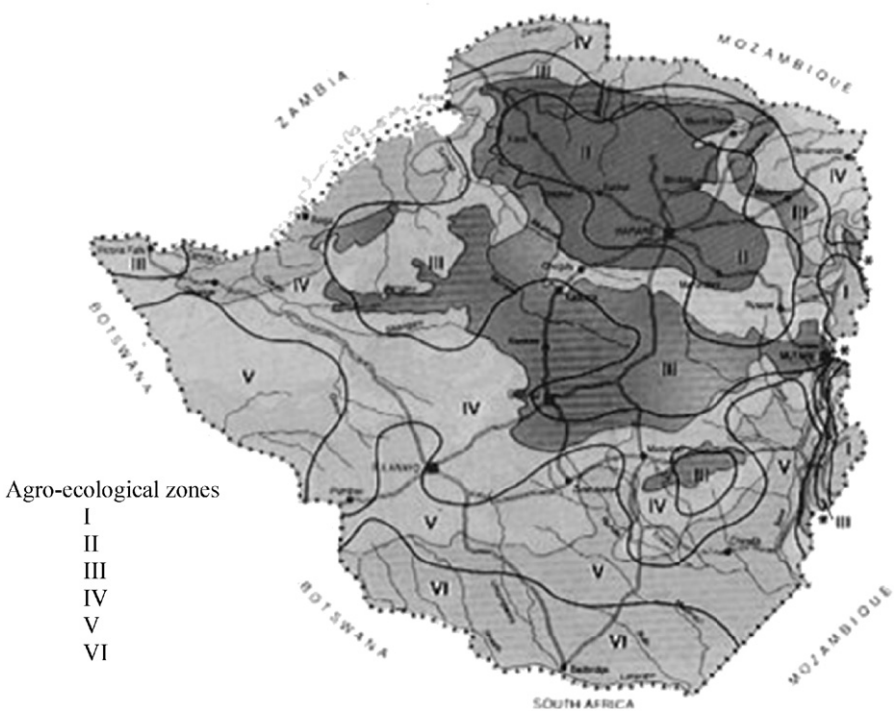

Fig. 1 – Agro-ecological zones in Zimbabwe [3].

mainly focused on fuelwood and animal wastes. Fuelwood is the most important domestic fuel in the country providing energy for cooking, lighting and space heating for over 80% of the population in the rural and peri-urban areas [3].

It is important to note that crop production is the most productive sector in Zimbabwe's agricultural sector and that large amounts of crop residues are produced each year. These residues are normally not visible in national energy statistics. This statistical invisibility secludes the crop residues from national energy budgets. This paper aims to assess the potential of crop residues as energy carriers in Zimbabwe.

2. Agriculture in Zimbabwe

2.1. *Agro-ecological zonation*

Zimbabwe is divided into 5 main agro-ecological regions based on differences in effective rainfall [8]. These regions are Natural region I–V. The geographical spread of these regions in Zimbabwe is shown in Fig. 1. Region VI shown in Fig. 1 is marginal area in the south of the country and is only suitable for game ranching. For agro-ecological purposes this part of the country is normally included under region V. Agricultural productivity decreases from region I to V in tandem with the decreasing rainfall from about 1000 to 400 mm per year. The rainfall and farming characteristics of these regions are given in Table 2. Natural region I is mainly used for fruit production and intensive livestock rearing. This region makes up less than 2% of the land area of Zimbabwe. Most of the crop production takes place in region II (15% of the total area) and region III (19% of total area). Over 50% of the country is made up of regions IV and V, which are suitable for livestock rearing.

2.2. *Crop production in Zimbabwe*

The major crops grown in Zimbabwe can be divided into three categories, which are: grain crops (maize, sorghum, wheat); cash crops (cotton, groundnuts, soyabeans, sunflowers, sugarcane, tea) and fruit crops. Crop production takes place mainly in Natural regions II and III. The major crops grown in region II are the grain crops, with maize being the dominant crop. Soyabean is the dominant oilseed crop and world production data show that Zimbabwe is the largest soyabean