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"Reconcile land system changes
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Evaluation of a photovoltaic-powered maize threshing machine for smallholder farmers in Rwanda

Janvier Ntwali[1], Wiomou Joévin Bonzi[2], Jean Jules César Mbarushimana [3], Joachim Müller[4]

[1] *University of Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group, Germany*
[2] *University of Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group, Germany*
[3] *University of Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group,*
[4] *University of Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group, Germany*

Abstract

Agricultural practices such as postharvest handling remain among the least mechanised in Africa compared to the rest of the world. In particular, threshing is carried out using traditional, labor-intensive methods that cause high operational costs, significant postharvest losses and reduced profitability. High cost of fuel and lack of grid electricity make mechanised alternatives impractical. This study investigated the performance of a photovoltaic-powered maize threshing machine designed for small holder farmers in the tropical regions with a focus on the north of Rwanda. Physical and mechanical properties of maize at varying moisture content were analysed and threshing experiments of maize cobs were conducted at varying rotational speeds under controlled conditions at the Institute of Agricultural Engineering, University of Hohenheim. The study assessed the threshing quality to determine the suitability of the machine for sustainable postharvest processing. The Young's modulus of elasticity ranged from 375.2 ± 312 MPa for maize at 9 % moisture content to 55.4 ± 24 MPa at 21 % moisture content. The 1000-kernel mass varied from 197.0 ± 33 g to 197.0 ± 42 g for maize at 9 % and 21 % moisture content, respectively. The percentage of broken grains was 23 ± 5 %, 29 ± 6 %, and 27 ± 4 % for maize at 9 %, 13 %, and 21 % moisture contents, respectively. No significant differences in energy consumption were observed across different rotational speeds and moisture contents. The optimal trial was threshing of dry maize at 9 % moisture content at a rotational speed of 420 RPM which resulted in an average power consumption of 400 W and a percentage broken grain of 17.3 %. Based on the results of physical properties, energy consumption and quality of maize, it was established that the developed threshing machine effectively reduced the grain breakage during threshing thus offering an affordable solution the postharvest losses reduction for small holder farmers in the tropics.

Keywords: Maize, mechanical properties, photovoltaic, postharvest, renewable energy, thresher

Contact Address: Janvier Ntwali, University of Hohenheim, Inst. of Agricultural Engineering, Tropics and Subtropics Group, Garbenstr. 9, 70599 Stuttgart, Germany, e-mail: janvier.ntwali@uni-hohenheim.de