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Drying studies of sorghum for forage and biomass production

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Abstract

Test plots of sorghum were planted and cut at maturity. Natural drying of the cut material was monitored in the field. Laboratory drying tests were conducted to determine the drying kinetics of the stalks under four different configurations at 50°C and 0.5 m/s air velocity. These included: 20 cm long sections with sealed ends to duplicate stalks of infinite length and remove "end effects"; 20 cm long sections with open ends to account for "end effects"; and 20 cm sections with longitudinal splitting to remove the effects of the outer layer of the stalks. In addition, short sections (5 cm) were dried to determine the impact of enhanced "end effects" on drying. Mathematical models were derived from replicate laboratory trials and were used to predict the times required to reach a final moisture content of 10% (wet basis). These times ranged from over 200 hours with the sealed ends to 15 hours with splitting of the stalks to expose the interior fully to the drying medium. Field drying of cut sorghum was found to be insufficient to adequately dry these materials for storage or use in energy production, especially under wet-weather conditions. Laboratory tests showed the need for substantial disruption of the stalk surface to promote drying. This can be achieved through mechanical maceration of the stalks. Simply cutting the stalks at ground level and relying upon open-air drying did not reduce the moisture content to acceptable levels for animal feed or energy production.

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Keywords: sorghum; drying; forage; biomass

1. Introduction

Sorghum is an important forage crop for cattle in many parts of the world. In addition, there is potential for this crop to play a greater role in energy production, particularly as biomass for burning (Bennett and Anex [1], and Türe et al. [2]). In order to reduce input costs, it is desirable to field-dry the crop before densification and storage. The use of forage crops (e.g., sorghum) for energy production may

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also alleviate the diversion of traditional food crops (e.g., maize) to energy production and return these crops to the human food chain. This would ultimately reduce considerable pressure on the economies of developing countries where maize is a staple food item.

Little information exists on the drying characteristics of sorghum, which could be a limiting consideration for biomass production in some climates. This study was undertaken to determine the drying kinetics of sorghum under a variety of drying.

2. Materials & Methods

Test plots of sorghum were planted and cut at maturity during two successive years (Figure 1). Natural drying of the cut material was monitored in the field.

Fig. 1. Field of uncut sorghum

Additional drying studies were conducted using an Armfield Model UOP-8 laboratory-scale tray dryer (Figure 2) to determine the drying kinetics of the stalks under various scenarios. These tests were conducted at 50°C with a linear air velocity of 0.5 m/s. Four different configurations of the sorghum stalks were employed to assess surface and "end effects". These were:

- 20 cm long sections with sealed ends to duplicate stalks of infinite length and negligible "end effects".
- 20 cm long sections with open ends to account for "end effects".
- 20 cm sections with longitudinal splitting to remove the effects of the outer layer of the stalks and eliminate "end effects".
- 5 cm short sections to determine the impact of enhanced "end effects".

Fig. 2. Armfield Model UOP-8 laboratory-scale tray dryer