Closing the Loop: Sustainable Material Use of Cardboard to Address Dwindling Market

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Abstract

Packaging, especially cardboard, is part of our daily lives on a college campus where virtually everything comes in boxes, thereby creating a vast volume of waste. Iowa State University (ISU), with over 33,000 students as well as about 6,000 faculty and staff, generates, on average, 70 tons of cardboard boxes every month. A few years ago, baled cardboard was most in-demand, which made it a "commodity" that generated revenue but not anymore due to the challenging US recycling market impacted by China's "National Sword" policies. Communities across the US, including higher education institutions like ISU, have been affected by the disruptions in the recycling markets, which has led to increased costs, putting strains on funds. As a result, many communities and institutions have stopped recycling these materials and are sending them to landfills, which is a cause for concern.

As a leader in advancing sustainability initiatives, ISU explored alternative solutions to cardboard recycling by using campus-generated cardboard boxes for animal bedding and compost. ISU's animal farms use corn stovers for animal beddings. Two different commercial methods (grinding and shredding) were used to breakdown boxes to determine the best bedding material type for cattle. The shredding method produced a baleable kind of cardboard that were quickly processed, which were applied as beddings for two months, and compared with corn stovers to determine its effectiveness. We experimented with eight animal pens on the same schedule placing four with shredded cardboard and the other four with corn stovers. Four pens were stocked light (i.e., four animals per pen), and another four pens were stocked heavy (i.e., seven animals per pen). Cattle were bedded twice weekly for four weeks, and the pens cleaned out after two weeks with pictures were taken regularly to compare results as well as the behavior of the animals.

Results indicate that the pens with shredded cardboard remained dry after four days, the cows were clean, and the feed intake was consistent. It had a better absorbent characteristic, and the cattle appeared comfortable on the cardboard bedding than on the corn stover. Other observed benefits include it's environmental, and health-friendliness for the cattle, which eliminates dust and potential molds, and the cattle had no tendencies of eating them. On the other hand, pens with corn stovers showed poor absorbent properties after four days, making the cattle dirty, uncomfortable, and food intakes inconsistent. Also, pens with corn stovers produced dust, and animal consumption of corn stovers affected animal research.

The shredded cardboard bedding was composted for soil amendment, thereby increasing soil nutrients. A manure analysis was conducted for both cardboard and corn stover bed materials, and it revealed that cardboard-composted bedding was denser than corn stover and the processed cardboard beds composted much faster than corn stovers. However, composted corn stovers had higher nutrient values than cardboard compost with conclusions made based only on the soil requirements of the farm. This characterization may not apply to other farmlands with different soil requirements.

Keywords
Cardboard, Animal Bedding, Compost, Circular Economy and Sustainable Materials Management

Biography

Ayodeji Oluwalana is the Recycling Coordinator in the Facilities Planning & Management Department at Iowa State University, Ames, Iowa, USA. He holds Bachelor of Environmental Management and Toxicology from Federal University of Agriculture, Abeokuta, Nigeria and Master in Environmental Management from Western Colorado University, Gunnison, Colorado, USA. He has designed projects that has helped advance upcycling and sustainable materials management concept in struggling US rural communities with limited waste management infrastructure (Gunnison, Colorado) by reusing plastic bottles for greenhouse construction to help local farmers. He significantly contributed to the Iowa Department of Natural Resources "Sustainable Materials Management- Vision for Iowa" Think Tank group to create a sustainable materials management vision for the State of Iowa as a statewide guide for future materials management related issues. His research interests include sustainable materials management, circular economy, life cycle analysis, material flow analysis and industrial metabolism. He is an elected board member of Iowa Recycling Association, member of Solid Waste Association of North America (SWANA) and the Association for the Advancement of Sustainability in Higher Education (AASHE).

Joshua Emakhu is a Ph.D. student, and Graduate Teaching Assistant in the Department of Industrial and Systems Engineering at Wayne State University, Michigan, USA. He earned his B.Sc. in Civil Engineering from Covenant University, Ogun State, Nigeria, and a Master's in Industrial Engineering from Wayne State University, Michigan, USA. His research interests include data analytics, medical devices, recalls, healthcare resource allocation, and voice of the customer. He is a member of IEOM, INFORMS, SAVE Int'l, and IISE. He is also a peer reviewer for IISE, RIED, and Frontiers for Psychology.