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Research article

Storage of woodchips in pressed bales

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ABSTRACT

Transportation and storage are two mainly critical operations of biomass supply chain because the transport must be performed using specific trucks, while in storage large areas are required. The goal of this work is to evaluate if the woodchip stored in pressed bales wrapped with waterproof sheets, as well as being a viable solution to reduce the storage area, is also a valid storage technique.
The study was carried out in northwest Italy whereby pressed bales made of woodchip produced by two different tree species (poplar and black locust) were stored by two different methods (covered and uncovered).
During the whole storage period the internal temperature values of bales were similar to air temperature values in all storage systems. Furthermore, no significant variations were obtained from two tree species tested between initial and final values of moisture contents (55% for poplar and 44% for black locust) and LHV (7.92 MJ kg^{-1} for black locust and 7.04 MJ kg^{-1} for poplar).
This storage method, although it does not allow an adequate woodchip drying, could be considered an acceptable alternative to other storage techniques because it does not show losses in terms of energy and dry matter for a period of two years.

1. Introduction

Wood biomass is a valid alternative to oil-based fossil fuels for energy production. Many governments encourage its use with economic incentives and numerous studies use specific mathematical models to predict its economic sustainability [1]. A negative aspect of wood biomass use is its high variability in form and density that require size homogenisation using specialised chipper machines [2]. Chippers produce wood chips of a standard size that are suitable for all automatic power station feeding systems [3]. Usually, chipping is performed as soon as possible in order to simplify the biomass supply chain [4]. Nonetheless, wood energy chains still present weak points, especially in woodchip transportation [5] and storage [6].

Biomass transportation is critical because the vehicles used must have a high versatility and low operating costs [7–8]. If an incorrect choice of vehicles is made the final woodchip cost can increase by up to 20% [9]. Vehicles used in woodchip transportation should be able to load different biomasses directly in the field. In addition, these vehicles should be loaded using standard farm equipment (e.g., tractors equipped with frontal loaders, and agricultural loaders) [10]. Generally, woodchips are transported using specific trucks equipped with a container sized to obtain the maximum volume allowed by road standards, defined as “trucks with large volumes”. Unfortunately, these trucks can only be loaded by specific handlers able to reach heights of at least five meters (telescopic handlers) that have a high rental cost [10–11].

On the other hand, storage operation is critical due to problems mainly linked to dry matter losses and to the large area required [12]. Woodchip is mainly produced in autumn and winter but the biomass-fired power stations need the biofuel throughout the year [13]. In order to avoid any interruption in the supply chain it is necessary to store the woodchip at the user plant or in the farms [14]. Independently through the location choice or techniques adopted in biomass storing, the major problem is the surface area required because the woodchip has a low density value [6,12,15].

Manzone [16] found a potential solution to this problem in the course of an experimentation carried out with an agricultural compactor. In fact, using this machine, it is possible to build high-density bales of comminuted wood wrapped with a waterproof plastic film [16]. Woodchip pressed into bales is a valid solution in transport operation because all trucks equipped with a load floor can be used and in storage because pressed bales can reduce the required storage surface area ten-fold [16].

In order to verify whether the bales wrapped with waterproof sheets is also a valid storage technique, an ad hoc study was carried out in northwest Italy whereby pressed bales made of woodchip produced by two different tree species (poplar and black locust) were stored by two different methods (covered and uncovered).

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Fig. 1. The agricultural compactor used to make bales.

2. Materials and methods

The study was carried out in Turin, northwestern Italy, between January 2014 and January 2016 (two years). This time period may seem long compared to the usual storage period (six months [6,12]). However, this long period is considered necessary to verify the potential of this storage technique. In order to highlight eventual differences in drying dynamics, tests were performed using woodchip produced by two forest tree species: high-density tree species (black locust – *Robinia pseudoacacia*) and low-density tree species (poplar – *Populus x euroamericana*). These tree species are considered representative of the two wood categories because they are most common on North Italian farmland and normally used for energy production [17].

The woodchips used in the trials were obtained from twelve-year old biomass plantations. All material was comminuted in the field by a drum chipper (Pezzolato PTH 900) and immediately processed. Bales were made using an agricultural compactor (Orkel MP 2000) considered to be suitable for this purpose [16] (Fig. 1). This compactor is mainly used in the agricultural sector for the wrapping of milling products and silage. Twelve bales were made for each tree species tested (poplar and black locust). Half of these (six bales) were stored under a roof and the other six bales in open air. A telescopic handler equipped with a specific crab device was used to move and pile the bales (Fig. 2).

Variations in moisture content and dry mass were monitored to assess the storage dynamics: a high moisture content reduction and a low dry matter loss mark a successful storage. Another parameter

Fig. 2. Telescopic handler used to move the wrapped bales.