BIOMASS COMPRESSING – PROCESSING USING AN INNOVATIVE HARVESTING HEAD

Young forests represent an unexploited source of biomaterials to supply the future biorefineries in the Botnia-Atlantica region. However, the bulk density of harvested biomass must be increased to achieve higher payloads on the forwarder and trucks in order to reach high efficiency when delivering un-comminuted biomasses to industries. A field trial was carried out to investigate the compression effect on tree bunches by the use of a prototype harvesting head able to fell, compressing-processing and buck small trees. A total of 20 bunches of different tree sizes were produced, half of them processed by feeding through the head feed-rollers and half unprocessed. Results showed a 76% increase in bulk density when processing bunches of large trees, and 35% for smaller ones. A 5-7% of whole tree foliage mass was scraped off from tree branches during the compressing, meaning that a significant amount of nutrients can be left in the forest and the fuel quality increased.

INTRODUCTION

Young dense forests represent an unexploited source of small-diameter trees to supply the future biorefineries in the Botnia-Atlantica region. However, small tree sections harvested from early thinnings are a bulky assortment. For this reason, there is a need of increasing the density of harvested biomass, which will lead to higher payloads on the forwarder and increase the efficiency in the whole supply chain. One innovative solution has been provided by Bracke Forest AB; a new prototype harvester head ("MAMA") able to fell, compressing-processing and buck bunches of small trees by means of purpose-built feed-roller system.

THE EXPERIMENT

A field trial was executed in November 2013 in a forest near Umeå with the aim to investigate the compression effect on tree bunches by using the head. The experiment also intended to find out the amount of foliage mass scraped off due to the processing and its effect of nutrient/ash reduction of bunches. The field trials produced 20 bunches of pine trees divided into two size classes: a class of bunches containing "small trees" (10 bunches, 5 trees/bunch, including trees with diameter at breast height (DBH) from 4 to 8 cm) and a second class containing "big trees" (10 bunches, 3 trees/bunch, including trees with DBH from 8 to 13 cm). Within each class, half of the tree bunches were felled and bucked (unprocessed bunches), and the other half of bunches were processed, e.g. fed into the head feed-rollers (processed bunches). A blanket was laid underneath the head to collect the branches, needles and

Figure 1. The "MAMA" head used in field trials for processing a bunch of trees on a blanket to collect the scraped-off biomass.

small fractions falling while processing the bunches. The collected biomass was then scaled (Fig. 1). For each of the bunches, the length, the circumference at butt, middle and top, and the weight were measured (Fig. 2). Afterwards, 3 bunches from each treatment were randomly selected and transported to the Biofuel Technology Center (BTC) in Umeå. Then, each of the bunches was individually chipped and sampled to assess the fuel quality: moisture content, particle size distribution, ash content and energy content.

RESULTS

The compression effect was more evident on the big tree bunches, with a 76% increase in bulk density, while the effect was minor on the small tree bunches, with a 35% increase (Table 1). In average, 2 Oven-Dry kg of branches, twigs, needles and bark per bunch from the small trees bunches and 4 OD kg/bunch from the big trees bunches were collected. It means that 5% of the biomass of small tree bunches and 7% in the big tree bunches was scraped-off during compression. Although a decrease of harvested mass also means lower harvesting productivity and income, this is expected to have a positive effect on the nutrient balance and fuel quality (e.g. decreasing the ash content). These results are in line with previous studies on the prototype MAMA head, where a 17-24% increase in forwarder payloads was found, which in turn resulted in a 47-70% increase on bulk density when biomass was stacked in a pile at road side.

Table 1. Characteristics of the studied tree bunches in average values and difference (Δ) between non-processed and processed bunches. Average moisture content was 56 %.

	Small trees			**Δ**	**Big trees**			**Δ**
	Unprocessed	**Processed**			**Unprocessed**	**Processed**		
DBH trees (cm)	5.7	5.9			9.8	9.8		
Height trees (m)	7.0	7.1			9.3	9.4		
Mass bunch (OD kg)	36	*Before*	*After*		70	*Before*	*After*	
		38	36	-5%		62	58	-7%
Volume bunch (m^3loose)	0.6	0.4		-32%	1.1	0.6		-41%
Bulk density (OD kg/m^3)	65	88		+35%	67	117		+76%

LITERATURE

Bergström, D. & Di Fulvio, F. Studies on the use of a novel prototype harvester head in early fuel wood thinnings. (Manuscript submitted to the International Journal of Forest Engineering 2013-11).

Bergström, D., Nordfjell, T. & Bergsten, U. 2010. Compressing processing and load compression of young Scots pine and birch trees in thinnings for bioenergy. International Journal of Forest Engineering 21(1): 31-39.

Figure 2. Scaling of the tree bunches by means of a dynamometer and a forwarder crane.

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