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Environmental benefits from the use of the residual biomass in nurseries

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ABSTRACT

Every year, nurseries waste about 40 t of residual biomass for each ha of potted plants cultivation. The European nursery sector deals with about 90,000 ha of cultivated land and 120,000 ha of nurseries, with a turnover of 19.8 billion Euros in 2011. In recent years, a number of Italian projects highlighted that GHG (greenhouse gas) emissions for the nursery sector range between 37 $tCO_2eq/ha/year$ and 45 $tCO_2eq/ha/year$ for potted plants, mainly due to the consumption of electric energy, plastics and peat. Moreover, other studies analyse the impacts associated to nurseries, recommending best practices for energy reductions and waste recycle or reuse. Therefore, the present work focused its attention to the possible environmental benefits associated to the reuse of residues (wood and substrate) of potted plants that are discarded from the nursery production chain. GHG emissions and fossil energy requirement were quantified by considering the CO_2eq (CO_2 equivalent) and the CER (cumulative energy requirement) respectively, in order to assess the environmental impacts of two different scenarios proposed for the materials recovery. Final results highlighted that the solutions which are able to recover the substrate and the wood allow impact reductions compared to landfill disposal. In particular, the scenario consisting in the immediate separation of the substrate from the root-plant system and the successive chipping of wood for energetic reuse, allows higher savings than those obtainable through shredding and subsequent wind separation. Moreover, for what concerns the CO_2eq, an adequate use of the residual biomass make it possible to compensate the GHG emissions of the nurseries up to 15%.

1. Introduction

The nursery sector in Europe involves 90,000 ha of cultivated land and 120,000 ha for nurseries (MiPAAF, 2012). Production reached 19.8 billion Euros in 2011 (Ierugan, 2012), mainly concentrated in the Netherlands (33%), Italy (13%), France (12%), Germany (12%) and Spain (11%). Considering Italy, up to 13,000 ha concern potted flowers and plants. Despite of the large area occupied by nurseries and the sector economic relevance, most Italian companies are characterised by their limited size: actually, 64% of nurseries have less than 1 ha extension (Ismea, 2011; Regione Toscana, 2006).

A number of Italian projects (Lazzerini, 2010; Nicese and Lazzerini, 2012) highlighted that the GHG emissions for the nursery sector ranges between 23.2 $tCO_2eq/ha/year$ and 32.2 $tCO_2eq/ha/year$ or 37 $tCO_2eq/ha/year$ and 45 $tCO_2eq/ha/year$ for potted flowers and plants, mainly due to electric energy, plastics and peat consumptions. These emissions represent about 2% of GHG emissions of the overall Italian agricultural sector (EEA, 2013) which, in its turn, is responsible of about 6% of national emissions amount, even if the area occupied by potted plants cultivated outdoor is only 0.1% of the utilised agricultural area (Agristat, 2013). As a consequence, nursery sector has a marginal importance on a national GHG emissions, but can have a significant impact at local level, greater than other agricultural operations. The results of Lazzerini (2010) show that some GHG reductions (10–16%) can be obtained by adopting bioplastics and/or peat recovering. Other studies carried out in Oregon, USA (CFNP, 2011; Food Alliance, 2012) analyse the impacts associated to nurseries, recommending best practices for energy reductions and waste recycle or reuse.

Actually, wastes, residues and by-products of nurseries can be managed in different ways. In particular, unsold trees with their substrate represent a significant quantity of organic material which is sometimes stored, shredded and reused. These operations are

Abbreviations: CER, cumulated energy requirement; CO_2eq, CO_2 equivalent, metric measure for comparing the emissions from various GHGs on the basis of their global-warming potential (GWP); GHG, greenhouse gas; GWP, global warming potential; LCA, life cycle assessment; LHV, lower heating value; RED, renewable energy directive.

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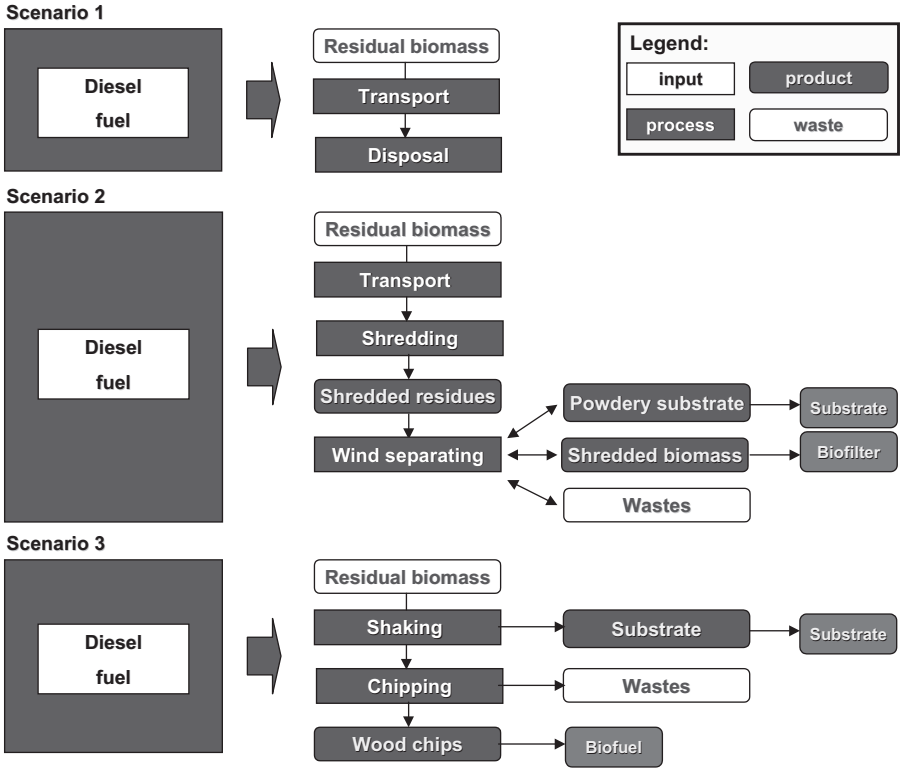

Fig. 1. Flow charts of the possible chains for the residues management: Scenario 1 with residues disposal in landfill; Scenario 2 with substrate recovery and biofilter production; Scenario 3 with substrate recovery and solid biofuel production.

more effective if different residual biomass typologies (wood and substrate) are separated by shaking before of the wood chipping, in order to improve their reuse and achieve a more effective substitution of raw materials. Depending on the level of main component separation and on recovered product quality in terms of purity, size, etc., the wood can be reused as a biofilter or as a solid biofuel, whilst recovered substrate can be mixed to virgin one in quantities which are as greater as minor compounds are present in it (e.g. stones, ferrous materials, plastics, etc.).

Starting from these assumptions, the present work focused its attention to possible environmental benefits associated to the reuse of residual biomasses, i.e. wood and substrate, of potted plants which are discarded from the nursery production chain. Three different scenarios for materials management recovery were investigated. In order to assess the environmental impacts of each scenario, GHG emissions and fossil energy requirement were quantified by considering the CO_2eq and the CER respectively. All data used in this work were collected in a nursery in the Province of Pistoia, Italy which represents one of the most important production area for nursery sector both in Italy and in Europe. Results obtained exploiting a LCA approach provided useful suggestions to reduce the environmental impacts of nurseries. Moreover, inventory data used in the present study could be used for additional considerations on economic and operational aspects of residues management and mechanisation in nurseries.

2. Materials and methods

2.1. Description of the scenarios for the residues management

Nursery operations generate biomass wastes that may be disposed or reused. Unsold trees are extracted from the vessels in which they grew and then they are accumulated in a clearing area inside the nursery, waiting for successive treatments. Residues consist of the whole plant, including roots and substrate contained in the vessel.

Different residue management chains (see Fig. 1) are possible:

- All the biomass, i.e. wood, roots, substrate and other waste materials, are disposed in landfill, as described in the Scenario 1. This chain was the most common one for nurseries located in Tuscany up to few years ago, but now it is being progressively supplanted by other chains in which residues are partially recovered.
- The biomass is sent to a treatment plant where shredding and wind separating are performed, producing powdery substrate, wood with substrate traces, iron and stony materials, as illustrated in the Scenario 2. The powdery substrate may be mixed with the virgin substrate with a share of 10%, whilst the wood is used for biofilters production.
- The biomass is gripped and shaken in order to separate the substrate from the roots and the plant. Then the whole plant is chipped obtaining wood that can be used as a solid biofuel in small or medium sized boilers for heat production, as proposed in the Scenario 3. The recovered substrate can be used instead of the virgin one, even if this choice can eventually increase herbicides consumption.

The scenarios proposed do not consider the production and transportation of the machines used in the yards, as such as the site construction and the consumptions associated to the nursery management. Moreover, also the transport from the production site to the nursery of the virgin substrate was excluded because of the lack of this information.

2.2. Definition of the methodology

The work was carried out implementing the LCA approach to the different chains illustrated in Fig. 1, in order to assess their