Possibilities for the processing LLDPE waste plastic produced by agricultural farms

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1 Introduction

In Finland, agriculture produces about 7,000 tn LLDPE (Linear Low-Density Polyethylene) waste plastic (e.g. Paukkunen 2024). The largest use of LLDPE waste plastic in agriculture is fresh feed for beef cattle, which is stored in the coated feed bales of the plastic film. After the use of feed bales, each bale will leave a waste plastic weighing about 1.5 kg (e.g. Tepponen 2019), which is challenging due to contamination, storage and financial challenges (Korhonen et al 2024). It is the responsibility of the farms to dispose of waste plastic, as farms are companies and consumers waste management is not intended for companies. A major challenge is the questionable storage of waste plastics on farms (courtyards, fields), which are suspected to cause micro-plastic emissions to the environment. Temporary storage also causes a deterioration of plastic raw material, which creates new challenges for reuse. Long transport distances for waste raw material poses a challenge of economic operation, especially in small size processing activities.

This article sets out the criteria for the possibilities and challenges of the waste plastics produced by farms. The article introduces the new product made of LLDPE waste plastic and the possible production of this product. The article is based on two LIFE project projects, CIRCWASTE-Finland (LIFE15 IPE 004) and PLASTLIFE (LIFE21 IPE FI Plastlife) and introduces the results and findings of the projects.

2 Material and methods

The article consists of the results of three studies (I, II and III). As a raw material for practical experiments, the agricultural LLDPE waste plastic and blend with waste plastic and wood planer chip were used.
Granulate 1 was purchased ready from Ostrobothnian Plastics LTD, which used water washed and dried waste plastic as raw material for the recycled granulates.
The granulates 2 and 3 were made from the pre-treated (by CIRCWASTE-project) waste plastic. Water washing or drying was not used during the pretreatment of the waste plastic, but the plastic was cleaned and dried along with mechanical pre -treatment. After the pre-treatment, the raw material was in flakes of about 3 mm.

The raw materials were collected, pre-processed and granulated as a procedure for the CIRCWASTE- project (Paukkunen 2024). Granulate 3 was a hybrid that contained 50% wood chips and 50% waste plastic (the same as granulates 2). The granulates (2 and 3) were manufactured by Elastopol Oy. The studies used LLDPE granulates made of commercial fossil oil as a reference (granulate 4).

The cost of transportation of plastic waste produced on farms was calculated using the GIS-based calculation model (CIRCWASTE, Teppola 2019). Standard test rods were made by injection molding machine that used the granulates of the study as a raw material. Test rods were analyzed in different test sessions: Experiment I (CIRCWASTE, granulate 1, Korhonen et al 2024), Experiment II (CIRCWASTE, Paukkunen and Olifirenko 2023, granulates 2 and 3) and Experiment III (PLASTLIFE, Tuovinen and Ruuska, 2023, granulates 2 and 3).

3 Results and discussion

The results of the experiments are that LLDPE waste from farms can be used as a raw material for injection molding without water or chemical treatment (Paukkunen 2024). At the same time, it should be noted that the quality of the waste raw material is reduced during storage during storage due to temperature, humidity and UV radiation (Tuovinen and Ruuska 2023).
The cost of transportation of raw materials varies greatly due to the effects of the equipment and collection frequencies used for transport (Tepponen 2019). According to preliminary LCA analysis, the most important steps in the production of circulated LLDPE products are granulation and raw material (PLASTLIFE, unpublished, Pohjonen ja Paukkunen). Based on the quality data of the waste material, KUAS (Karelia University Of Applied Sciences) designed a new product (PLASTLIFE 2024, unpublished, Paukkunen et al), for which KUAS designed and made an injection mold. The product will be publicly presented in Joensuu in April 2024 at the PLASTLIFE project consortium meeting. A new product was designed and manufactured as a measure of the Plastlife project to see new access to both the construction industry and the filtration technology. The project explores the environmental impact of recycled plastic through LCA modeling.

More efficient recycling of agricultural LLDPE waste plastic still requires development in the formation of raw material formation and product manufacturing technology. Technically, making such a product developed in the PLASTLIFE project is possible by injection molding, but technically 3D printing could be more appropriate.
According to LCA calculations (PLASTLIFE, unpublished, Pohjonen and Paukkunen), making and melting granulates in the injection machine takes a large part of the total energy of making a recycled product. Already, there is a technical solution where you may not need to granulate recycled plastic, but the product can be made by 3D by printing directly from chopped plastic. The LCA calculations are to be refined with device-specific energy consumption in the spring of 2024.

4 Conclusions

Recycling of waste LLDPE is possible, but as a small -scale implementation it is challenging. Waste treatment also needs an environmental permit, so from a local and small company, such activities that need an environmental permit can be seen as too complex, bureaucratic and economically too risky.

5 References.

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