sustainability

Case Report

Innovative Strategy to Reduce Single-Use Plastics in Sustainable Horticulture by a Refund Strategy for Flowerpots

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Abstract: *(1) Background:* Black plastics pose a general problem in sustainability issues, as the recycling is hampered by the black colour disguising the type of plastics in the NIR scanner on the garbage sorting belt, as the black colour absorbs NIR radiation. Sorting flower/plant pots suffer from their additional soil contamination in the strive for sustainable flower production in horticulture. As these black plastic flowerpots are currently rarely recycled, a study was instigated of reusing them based on Heino Schwarz's innovative idea. *(2) Methods:* In the first step, the carbon footprint was calculated for the flowerpots of two sizes employed in the nursery, their customised production from virgin polypropylene and the delivery from the Netherlands to the nursery in Bavaria. In step 2, the carbon footprint was calculated based on PAS 2050-1 for the number of flowerpots in circulation and return rates in 2019 and in 2020 to assess the GHG saved by the innovation. *(3) Results:* The innovative concept of Heino Schwarz is a discount on returning the customised used flowerpots, with a 40% increase from 24,533 returned flowerpots in 2019 to 39,797 in 2020. This shows the increasing acceptance and environmental awareness of the consumer and the great success. *(4) Conclusions and outlook:* The present case study has shown that innovative approaches such as discounts for reused/returned flowerpots of the Schwarz nursery can save 3.85–4.56 t CO_{2eq}, a valuable contribution to reducing GHG emissions, creating environmental awareness among the consumers and building a close B2C relationship. The amount of CO_{2eq} saved is equivalent to ca. 40% of the annual carbon burden of a European/German citizen or ca. 23,000 km driven in a private vehicle, the average mileage driven privately in two years.

Keywords: circular economy; GHG; PAS 2050; polypropylene; plastics disposal; sustainability

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1. Introduction

In horticulture, the majority of plant/flowerpots are made from a single plastic, i.e., polypropylene. Deployed flowerpots end up in either organic garbage (together with the plant in it), yellow recycling bags (Figure 1b) or recycling boxes, or the general reject bin (Figure 1a). After collection, black plastic poses a challenge in garbage separation (Geddes, 2019 [1]). On the garbage separation line, the type of plastic in any black plastic cannot be identified when being scanned by the NIR scanner, as the black colour absorbs the NIR and fails identification; recycling plant pots is additionally hampered by organic contamination. Hence, the majority of black plastics end up in incineration rather than being recycled by their type of plastic; in the industry, PP products are labelled "PP" or "5" [2–5].

In a strive for the reduction in plastic input in horticulture (Hess et al. 2020 [6]), several approaches such as the initiative "Re-think plastics" [4,7] have been described:

- Reduce—weight reduction;
- Reuse—to increase lifespan;
- Recycling;
- Use of alternative materials;
- Avoidance (of single-use plastic).

Among plastics, polypropylene (PP) has the largest energy requirement in its production compared with, e.g., PE or PET (Plastics Europe et al.) [2–5,7–9], and, hence, the largest carbon footprint of 3–4 kg CO_{2e}/kg PP depending on the source of energy and supply of granules. Polypropylene is too valuable to be wasted (Fig. 1d), particularly if pure (not mixed with other plastic types), and it could be recycled to polyolefins [5–9], if properly detected on the trash sorting lines [1,7,8]).

As reduce and reuse are the preferred strategies of the four "Re-s" [1] to combat single-use plastic waste, this contribution presents an innovative approach in the strive for sustainable horticulture to reuse plastics [6] in a case where recycling is impractical.

Figure 1. (**a**) typical disposal of single-use plant pots in household garbage in the general reject bin (**left**), or (**b**) yellow bag and (**c**) noncompostable garbage in a cemetery (**middle**) and (**d**) disposal (**right**).

2. Materials and Methods

2.1. Primary Activity Data—Case Study

Research was instigated and a case study devised based on Heino Schwarz nursery's innovative idea to reuse the plastic flowerpots, if they cannot be recycled easily, due to colour, impossible NIR recognition and the varying degree of organic contamination (Figure 1a). The underlying idea is based on three pillars: (1) To (i) create a financial incentive, where customers receive a deposit/discount on returning their own customised Schwarz flowerpots for reuse; (ii) increase customer awareness for the environmental burden of single-use plastics; and (iii) build up customer relations. (2) Pots from unsold plants are reused for planting new flowers for sale. (3) Pots from planting flowers in the local cemetery (Figure 1c) are not disposed on their garbage heap, but reused.

Primary activity data were based on Heino Schwarz sales records in 2019 and 2020. Data of returned flowerpots were from the check-out, where the discounts on new purchases are recorded digitally, and in-house sales records.

2.2. Pot Production, Polypropylene and Carbon Footprint Calculation

Among plastics, polypropylene (PP) has the largest energy requirement in its production compared with, e.g., PE or PET [1,2], and, hence, the largest carbon footprint. To cater for the variation in reported GHG emission values for virgin polypropylene, the calculations in Table 1 include the wide range of 3.4–4.0 kg of CO_{2e}/kg PP [6,9,10].

Table 1. Carbon footprint of polypropylene flowerpot production and their supply to the nursery—background colour visualises the differentiation between small 9 cm and large 12 cm flowerpots.

Type of Flowerpot (cm)	Weight [g]	Polypropylene [g CO_{2eq}]	Truck Transport [g CO_{2eq}]	Total [g CO_{2eq}/Pot]
9	6	20.6–24.6	0.8	21.4–25.4
12	13	44.5–53.3	1.7	46.2–55.1

Carbon footprint was calculated based on PAS 2050 and PAS 2050-1 [9,11]. The calculation included the greenhouse gas emissions (GHG) for the production of 9 cm and 12 cm flowerpots (Figure 2) made from virgin polypropylene.

Figure 2. Reusable customised solid PP flowerpots in the Schwarz nursery, Schwabach.

2.3. Delivery of Flowerpots

The flowerpots are transported from their factory in Leusden (Amersfort, The Netherlands) by a 25 t truck to the Schwarz nursery in Schwabach, Bavaria. The Schmied and Knörr (2018) [12] life cycle inventory (LCI) for European road transport, with 100 g CO_{2e}/t/km, was used to calculate the GHG emissions associated with the 631 km truck transport (Table 1).

3. Results

3.1. The Concept—Climate Friendly Customer Relationship

In 2019, Heino Schwarz introduced the innovative concept based on three pillars: (1) Customers of their nursery pay a deposit on each flowerpot and can reclaim this deposit or discount, when returning their customised used flowerpots. This offer is limited to returning solely their own customised flowerpots, which are made from polypropylene and are printed with their logo (Figure 2). (2) Pots from unsold plants are reused for planting new flowers. (3) Pots from planting flowers on graves in the local cemetery are not disposed at the graveyard, but reused for new flowers and plants.

3.2. Carbon Footprint of Flowerpot Supply

The calculations for the two sizes of Heino Schwarz customised flowerpots in Table 1 include the wide range of emission factors of 3.4–4.0 kg CO_{2e}/kg PP for polypropylene [6,9,10]. The life cycle inventory (LCI) for European road transport by Schmied and Knörr (2018) [12] with 100 g CO_{2e}/t/km was used to calculate the 631 km truck transport. This caused 0.8 g CO_{2e}/9 cm or 1.7 g CO_{2e}/12 cm flowerpot as GHG emissions for the transport from the Netherlands to Bavaria (Table 1), which played a minor role in the overall carbon footprint (Figure 3).

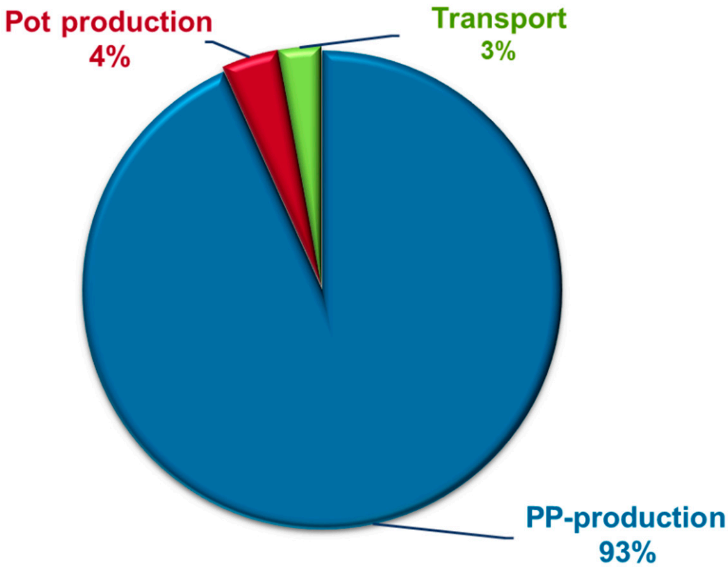

Figure 3. Percentage contribution of plastic production, pot production and transport to the carbon footprint of black plastic (polypropylene) plant pots.

3.3. Carbon Footprint of Cycling Flowerpots in the Nursery

In Heino Schwarz's nursery, 9 cm and 12 cm diameter flowerpots are in circulation in a ratio of 3:1. Check-out data show that, overall, 24,544 flowerpots were returned in 2019, which increased to 39,979 in 2020 (Table 2), a ca. 40% success and encouraging acceptance rate and environmental awareness by the customers; 7% of the returned flowerpots were discarded as waste, as they were broken or otherwise unusable.

Table 2. Primary activity data—pots returned to the nursery by size, year and waste (colour background indicates the years of data assessment—grey for 2019 amd blue for 2020).

Year	Returned Pots	Pot Size [cm]	Returned Pots	Including Waste *
2019	24,544	9	16,359	15,214
		12	8185	7612
2020	39,979	9	26,636	24,771
		12	13,333	12,400

Notes: * including 7% waste.

Table 2 shows the turnover of flowerpots in the nursery, partitioned to pot size (9 and 12 cm) and year (2019 and 2020); data include 7% waste of unusable damaged proprietary polypropylene pots. Based on the recorded number of pots returned by the consumer (Table 2), Table 3 shows the allocation and analysis of the carbon footprints for both pot sizes (9 and 12 cm) in both years (2019 and 2020). The reduction in carbon emissions by the deposit refund scheme increased from 0.68–0.81 t CO_{2eq} in 2019 to 1.10–1.28 t CO_{2eq} in 2020 when the return rate had increased by 40% (Table 3).

Table 3. Carbon footprint of the plant pots returned to the nursery by size and year (colour background indicates the years of data assessment—grey for 2019 amd blue for 2020).

Year	Returned Pots	Pot Size [cm]	Pots *	GHG Savings [t CO_{2eq}/Year]	Total [t CO_{2eq}/Year]
2019	24 544	9	15,214	0.33–0.39	0.68–0.81
		12	7612	0.35–0.42	
2020	39 979	9	24,771	0.53–0.60	1.10–1.28
		12	12,400	0.57–0.68	

Notes: * including 7% waste.

In addition to the returned pots (Tables 1–3), decarbonisation is achieved by reusing pots after retrieval from unsold plants (0.06–0.11 t CO_2) and, to a large extent, by pots retrieved from planting flowers in a cemetery (2.48–2.95 t CO_{2eq}) (Table 4).

Table 4. Carbon footprint of the plant pots reused from unsold plants and cemetery (colours indicate source of GHG emissions).

	Portion Unsold Pots	Pot Size [cm]	Pot Number	GHG Savings [t CO_{2eq}/Year]	Total [t CO_{2eq}/Year]
Pots from unsold plants	5–10%	9	30,000	0.035–0.069	0.06–0.11
	5–10%	12	10,000	0.025–0.050	
Planted in cemetery	90,000 pots	9	67,500	1.44–1.71	2.48–2.95
		12	22,500	1.04–1.24	

Figure 4 shows the carbon footprint of polypropylene in plant pots supplied to the nursery of Heino Schwarz, which increases from production to delivery and decreases significantly when recirculated. 30 or 50% recirculation were theoretically applied to demonstrate the potential of the carbon footprint reduction as a function of the recirculation rate. The second recirculation was much less efficient in reducing the carbon footprint compared to the first recirculation.

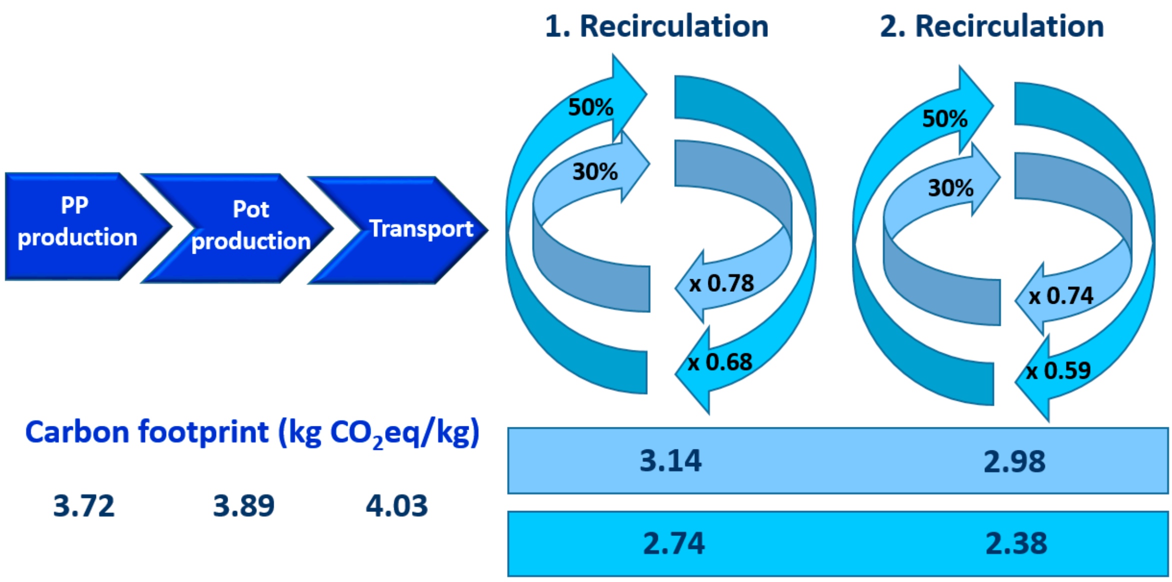

Figure 4. Carbon footprint of plant pots with 30% or 50% recirculation.

Figure 5 shows the contributions of each of the innovative ideas of the Schwarz nursery to decarbonise the horticultural supply chain, with the recovery of pots from unsold plants as minor, the pots returned by customers as intermediate, and the pots retrieved from flowers planted in the cemetery with the largest share (Figure 5).

The present case study shows that this deposit return scheme (Figure 5) successfully built a customer B2C relationship and encouraged customers' environmental awareness. It can save 3.85–4.56 t CO_{2eq} a year, a valuable contribution to reducing GHG emissions and plastic consumption and production, creating environmental awareness among the consumers and building a sustainable B2C relationship.

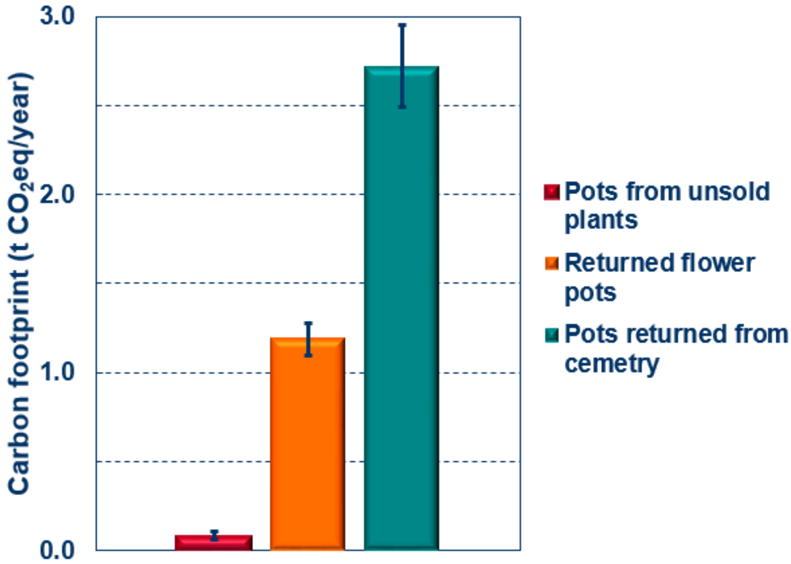

Figure 5. GHG emissions saved in each of the three pillars.

4. Discussion

Figure 6 shows the relative contribution to the GHG emissions saved by the three pillars of the Schwarz nursery concept, with the reuse in the graveyard representing the largest and the customer-returned pots the second largest share (Figure 6). The 40% increase within one year shows the success.

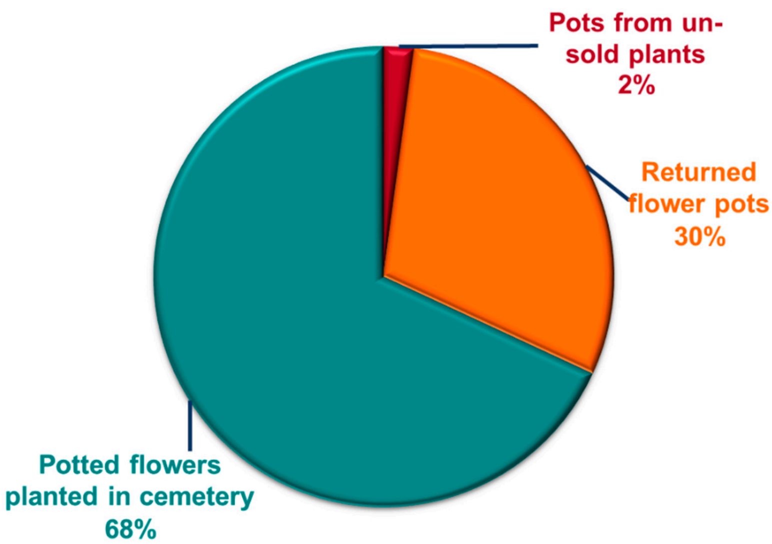

Figure 6. Sources of GHG emissions saved as percentage.

In 2019, Heino Schwarz introduced the innovative concept that customers of their nursery regain a deposit on returning their empty customised flowerpots with a new purchase. The innovation by Heino Schwarz is a prime example of creating consumer awareness in line with the "single-use plastics" EU Directive in order to reduce plastics in our society and in favour of more sustainable plant production. Our planet currently contains 250 billion tonnes of plastics, which increase by ca. 450 million tonnes annually (Plastics Europe) [2], with the potential contamination of our planet and a 100+ years lifespan before degradation and the threat of microplastics (GKL, 2020) [7].

Tesco's supermarkets in the UK operated a scheme in cooperation of reusing plastics viz. avoiding single-use plastics; customers with a plastic shopping bag received a discount at the check-out (for not needing a new plastic bag). Tesco is now expanding this deposit return scheme called LOOP to re-fillable food and drink, health and beauty, and cleaning products such as shampoos and soap dispensers in reusable packaging in collaboration with TerraCycle [13], who already operate in France and the US.

5. Conclusions

The present case study has shown that innovative approaches such as refunds on flower pots of the Schwarz nursery can save 3.85–4.56 t CO_{2eq}, a valuable contribution to reducing GHG emissions and plastic consumption and production, creating environmental awareness among the consumers and building a close B2C relationship. The amount of CO_{2eq} saved is equivalent to ca. 40% of the annual carbon burden of a German citizen [14] or ca. 23,000 km, the mileage driven in a private car by a citizen in 2 years or burning ca. 1500 L of heating oil [15]. The presented case study and innovative idea can be scaled up in all cases with direct B2C sales, but are inappropriate for B2B, wholesale or exports; in some cases disinfection of the flowerpots may be necessary.

6. Outlook, Scope and Upscaling

The innovative idea of Heino Schwarz (https://www.blumen-schwarz.de, (accessed on 21 June 2021)) is not geographically limited. There are 2831 nurseries in Germany (AMI, 2020) [16]. Enterprises, who sell direct to the end-user, i.e., consumer, could operate a similar policy. The carbon reduction potential is high and the nursery would additionally benefit from better customer relations. If 1000 nurseries with B2C marketing would follow a similar scheme, the carbon reduction potential would be of the order of 1900–4500 t CO_{2eq}.

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Conflicts of Interest: The authors declare no conflict of interest.

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