Australian Government
Department of Agriculture, Fisheries and Forestry

AUSTRALIAN Pork

Understanding and solving the use of veterinary plastic consumables in pork production

Final Report
APL Project 2022-0016

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Table of Contents

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Executive Summary

This project was initiated by Australian Pork Limited (APL) as part of the commitment to drive zero waste to landfill. The project team quantified veterinary plastic waste in the Australian pork industry and provided intervention options to divert these from being disposed to landfill.

A quantification model determined that the Australian pork industry produces 58 tonnes of veterinary plastic annually. This equates to 7,651,000 units of plastic that are disposed to landfill, incinerated, or buried on-farm. The breakdown of this plastic is provided in Table ES-1.

Table ES-1: Total veterinary plastics by weight and by unit.

VETERINARY PLASTIC GROUP	UNITS	PERCENTAGE	WEIGHT	PERCENTAGE
Units	**units/year**	**%**	**kg/year**	**%**
Medication primary packaging	372,356	5	7,030	12
Medication equipment	247,692	3	5,879	10
Insemination	3,083,443	40	23,346	41
PPE	3,381,808	44	17,724	31
Secondary packaging	565,509	7	3,575	6
Total	7,650,808	100	57,554	100

Of all veterinary plastic consumables disposed, insemination and Personal Protective Equipment (PPE) material were found to generate most wasted units and associated weight. These are problematic as they are not designed to be reused or recycled but are essential for the hygiene of workers and sows. Major shifts in use practices and supply chains are required to move away from single-use items to a more sustainable and circular pork industry.

A longlist of intervention options was identified for different changemakers, namely (i) Australian Pork Limited, (ii) suppliers and manufacturers and (iii) piggeries. The waste hierarchy which prioritises waste management was used to identify the impact of the intervention options for better management of veterinary plastics. The waste hierarchy for veterinary plastics with definitions and examples is provided in Figure ES-1.

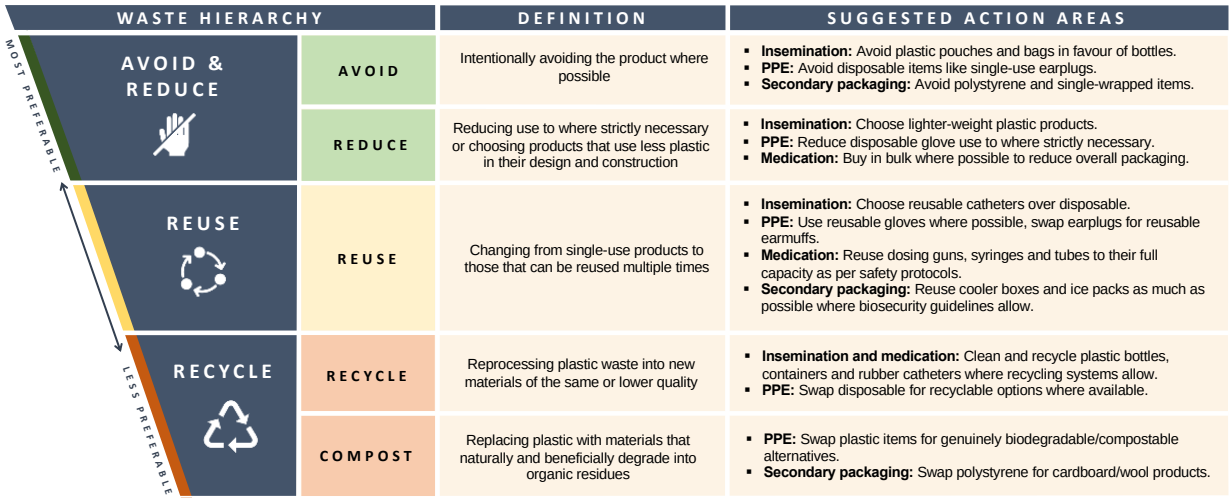

Figure ES-1: Waste hierarchy for veterinary plastics used in the pork industry.

From the intervention options identified, three were further explored being identified as able to be implemented by piggeries in the short-term. These options were:

- Separation and collection of bottles and syringes for recycling
- Replacing single-use gloves with certified biodegradable gloves
- Bulk insemination with insemination guns.

The pork industry has been proactive in considering its management of waste and potential for resource recovery to progress a more circular production system. This project has highlighted that there is much opportunity for improvement and if options are implemented the redesign, reuse and recycling of veterinary plastic consumables can become commonplace.

1 Introduction

1.1 This project

Australian Pork Limited's (APL) Strategic Plan 2020-2025 commits to driving a zero waste-to-landfill policy. The complimentary APL Closing the Loop Roadmap (Roadmap)[1] provides the plan to achieve this commitment and includes practical advice for how to improve management of a range of waste types (for example manure, rigid plastics, metals) and contribute to the circular economy. As highlighted in the Roadmap, organic wastes, or resources, offer good recovery options and these are well advanced in the industry. However, this is not the case for hard waste. In particular, there are limited solutions for veterinary plastic hard waste such as artificial insemination (AI) catheters, PPE and semen bottles as well as the associated packaging and storage items such as eskies and soft plastics. The Roadmap suggests that some materials can be recycled by tying into bundles and sending through a normal recycling service. However, the operational setting (staff skills, willingness, cost) and practical consideration (waste classification, storage, collections, cost, available recycler to accept material) can be challenging.

This report has estimated that veterinary plastics in the pork industry make up 58 tonnes/year of waste, which is disposed to landfill. These practices are unsustainable but to encourage a change to alternative practices, options need to be developed and the cost viability needs to be evident.

The issue of plastic waste is being addressed across all sectors with industry commitment and solutions developed through the Agriculture, Fisheries and Forestry Waste and Resource Recovery Roadmap[2] supported by AgriFutures. This project highlights the industry specific challenges associated with waste and resource recovery.

1.2 Project objectives and outcomes

The objectives of the project were to:

- **Map, describe and quantify** all plastic veterinary waste used in the pork industry
- **Perform an options analysis** of alternative optional material/products and/or better management pathways for current materials. This would include ease of implementation and special considerations such as equipment and process changes required
- **Perform a three high-level cases studies** of alternative material use or management pathways and their implementation and environmental impacts.

1.3 Key definitions

Key definitions of terms frequently used in this report include:

Waste is the disposed/no longer used for the purpose for which intended material.

Veterinary products are the veterinary therapeutics and medicines that serve to prevent, diagnose, treat, or alleviate diseases, conditions, infestations, or injuries in animals. They are also used to assist physiological processes linked to animal health[3].

Veterinary plastic waste are the veterinary therapeutics and medicines and their packaging which consist primarily of plastic which are disposed or no longer used.

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[1] APL Closing the Loop Roadmap https://australianpork.com.au/sites/default/files/2022-06/031722%20-%20APL%20-%20Closing%20the%20Loop%20Roadmap%20-%20V3.pdf

[2] Agriculture, Fisheries and Forestry Waste and Resource Recovery Roadmap, https://agrifutures.com.au/wp-content/uploads/2023/04/Agriculture-Fisheries-Forestry-Waste-Roadmap.pdf

[3] Department of Agriculture, Fisheries and Forestry, Veterinary products (2023), https://www.agriculture.gov.au/biosecurity-trade/import/goods/biological/checklist/vet-products (accessed: 9/8/2023)

1.4 Methodology

1.5 Whole project method overview

The project was conducted in two phases and eight steps as described in Table 2-1.

Table 1-1: Methodology summary

PHASE	STEP	DESCRIPTION
Phase 1 Focused on the quantification of veterinary plastics used in the pork industry	**Step 1** Identify and describe full range of plastics	Identified a list of materials veterinary plastic consumables used in the pork industry that was validated by APL and defined plastic polymer, colour and use.
	Step 2 Raw data collection	Engaged with five piggeries to capture their veterinary plastic waste and understand their management options and appetite for change.
	Step 3 Extrapolate raw data to representative systems and industry wide generation	Used the raw data captured in Step 2 to develop a Veterinary Plastic Waste model that estimates veterinary plastic waste. For a detailed description of the data collection and modelling refer to Section 2.2.
	Step 4 Present findings	Provided the Veterinary Plastic Waste model to APL and developed a PowerBi to visualise the results.
Phase 2 considering the options for management of these plastics with an emphasis on the circular economy.	**Step 1** Describe and assess the issue	Contextualised the results of the Veterinary Plastic Waste model to inform Phase 2.
	Step 2 Research options and solutions	Investigated options and solutions for redesign, reuse or recycling of veterinary plastic internationally or from transferrable industries (e.g. medical industry). This research is presented in Appendix C.
	Step 3 Assess options and solutions	Developed a long list of options for APL, suppliers and manufacturers and piggeries. Assessed all options against: the waste hierarchy, timeline for implementation and strengths and weaknesses including ease of implementation, change of processes and critical constraints. Facilitated a workshop with APL to gather feedback on the options and choose options to explore in more detail.
	Step 4 Present findings	Presented the results in a final report of: Veterinary Plastic Waste model Longlist of options Three high level business cases: 1) Separation and collection of bottles and syringes for recycling, 2) Replacing gloves with certified biodegradable gloves and 3) Bulk insemination with insemination gun

1.6 Plastic quantification method

1.6.1 Overview

The veterinary plastic model was essential to this report. The following figure (Figure 2-1) provides an overview of the methodology described in further detail.

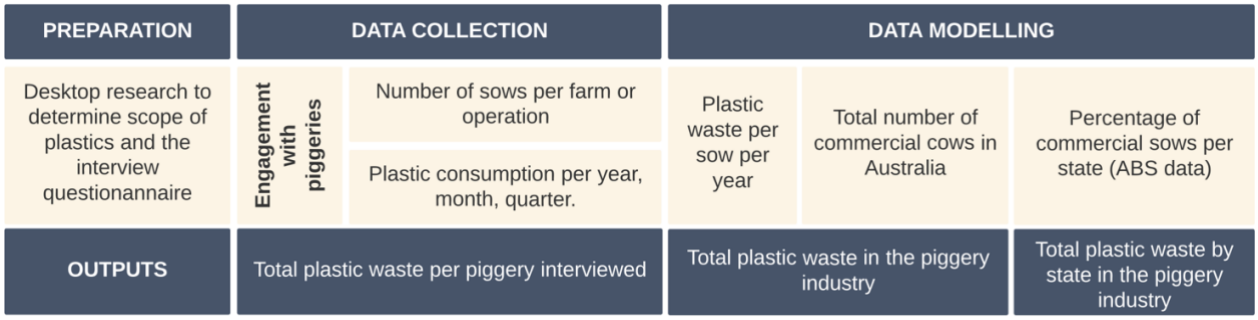


Figure 1-1: Overview of veterinary plastic model methodology.

1.6.2 Data collection

A questionnaire was developed based on a list of material plastics developed in conjunction with APL project staff. This was tested during two farm interviews where interviewees provided feedback on materials that the questionnaire was missing. The questionnaire was then updated to include the final list of plastics (see details in appendix A).

All interviews were conducted via videocall with follow up emails and/or phone calls to confirm the data. There were 5 farms interviewed that represent more than 50% of the total sows in Australia and are all considered large commercial farms.

Across different sizes of piggeries, it was found that the per sow plastic material consumption was fairly consistent.

1.6.3 Data modelling

All data was recorded, modelled and analysed in Microsoft Excel.

All interview data was initially cleaned and sense checked and assigned a quality rating. The rating was based on the granularity of data provided in the interviews and each material was assigned a degree of accuracy based on the variability of reporting.

The reported material use was then divided by size of the operation (number of sows) to develop a 'material use/sow' factor. Not all interviewees had reported all materials used. As such, a second assessment of the data, through the quality rating and follow up conversations or emails with interviewees, determined:

- What materials were used by all farms but had not been reported – in which case the 'material use/sow factor' from another business was applied
- What materials represented different farm practices (such as in house semen collection or external) – in which case the 'material use factor' was averaged.

The 'material use/sow' factor was used to derive a typical per sow profile that was then used to extrapolate to farms of different sizes. In order to convert the units of materials used to weight a

desktop review informed the plastic weight of each product. Some product weights were available online (e.g. catheters) and some others were estimated based on size and thickness of plastic (e.g. plastic bags and wrapping). This resulted in two factors, 'units/sow' and 'kg of plastic/sow', that was extrapolated to three different farm sizes: small with 250 sows, medium with 500 sows and large with 2000 sows.

The combined 'material use factor/sow' and 'kg of plastic/sow' was then extrapolated using APL Australian production data (number of commercial sows). To estimate units and weight of plastic veterinary waste per state the total production data was assigned proportionally to each state based on the proportional number of sows in the ABS 2021 database.

1.6.4 Assumptions and data limitations

Representation

Based on responses, the interviewed farms constitute the large commercial farms, thus the results may not be as representative for all farms. However, it is representative of the pork industry as the sows in these farms make up most sows in Australia. If new farms are added, the model can be updated to incorporate these.

Plastic content of materials

For many products the plastic content was assumed - for example detectable needle cartridges 5% of the total waste was assumed to be plastic. Different methods were used to understand the % of plastic in a product. However, with some materials it was not possible to estimate the plastic percentage and thus the whole product was assumed as plastic.

Scope of materials

The list of materials was completed in conjunction with APL and as interviews progressed this was modified to include more or less materials. From the start the scope excluded medication feed bags and office plastics. Some materials were grouped in ways that could be further separated (e.g. semen pouches and semen tubes). However, other materials like syringes were separated by volume (e.g. syringes – 1ml, 2ml, 5ml, 10ml,20ml, 50ml). This was based on the reporting quality.

The granularity of data collected by material is provided in Appendix A.

2 Veterinary Plastics Quantification results

2.1 Results overview

An overview of plastic waste produced annually is provided in Figure 3-1 including types and volumes (weight and units).

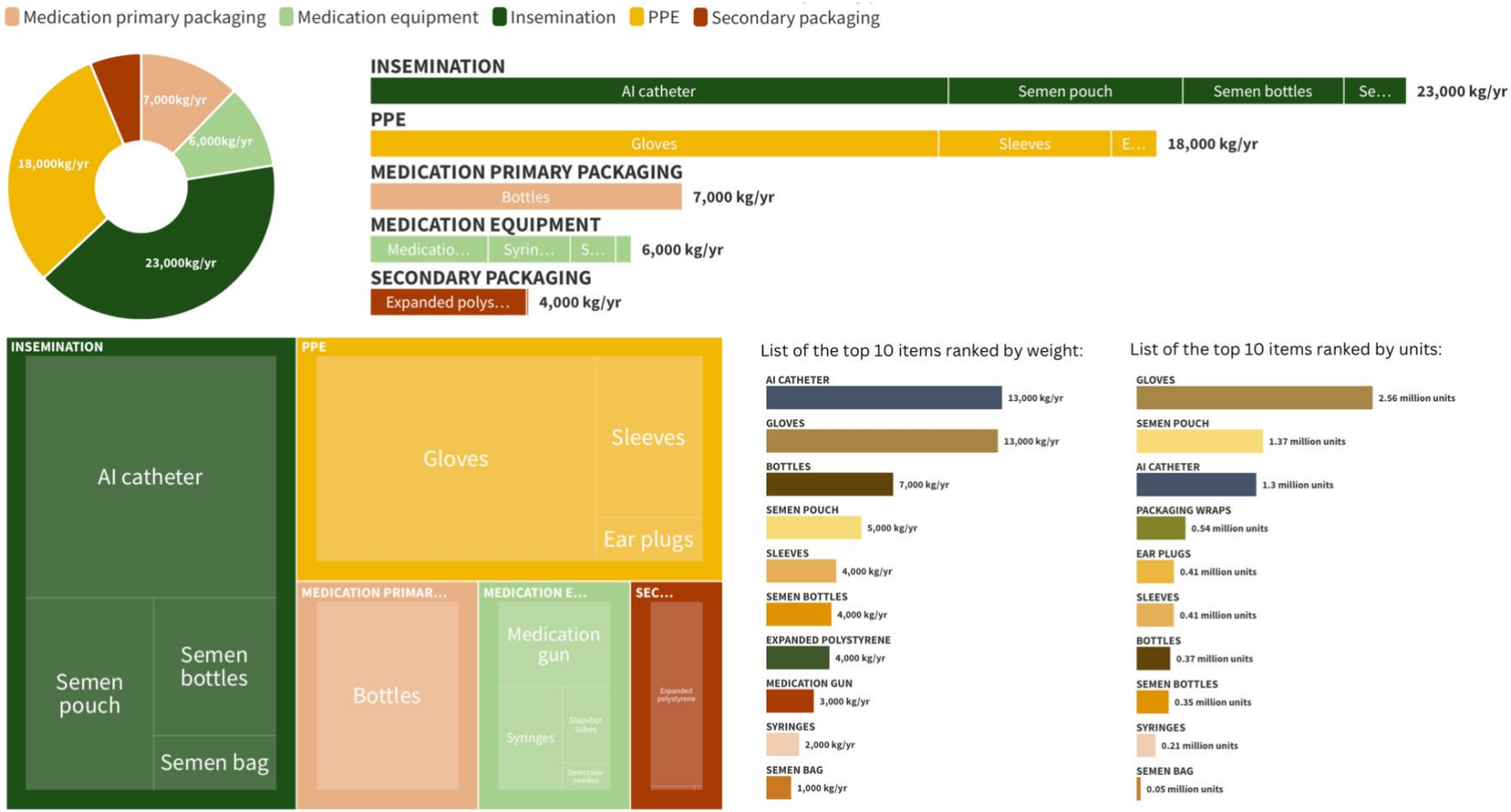


Figure 2-1: Types and volumes (kg and number of units) of plastic veterinary waste produced annually

2.2 *Detailed results*

2.2.1 Summary

A summary of the material types used in the industry (by number of units and weight) is provided in Table 3-1. Visual examples of the materials are provided in Appendix B.

Table 2-1: Total veterinary plastic weight and units.

TOTAL MATERIAL BY TYPE	UNITS	PERCENTAGE	WEIGHT	PERCENTAGE
Units	units/year		kg/year	
Medication primary packaging	372,356	5%	7,030	12%
Medication equipment	247,692	3%	5,879	10%
Insemination	3,083,443	40%	23,346	41%
PPE	3,381,808	44%	17,724	31%
Secondary packaging	565,509	7%	3,575	6%
Total	**7,650,808**		**57,554**	

2.2.2 Medication Primary Packaging

Medication primary packaging makes up 12% by weight of all veterinary plastic waste. This corresponds to 7.0 tonnes/year of plastic sent to landfill.

Medication primary packaging includes mainly bottles sized from 50mL to 20L that contain veterinary medication and other therapeutic products (e.g. obstetric lubricant). The shape of the bottle changes based on their desired purpose (e.g. some have spray nozzles, or nitrile caps for needle injection) and size. Larger bottles tend to have a more rectangular shape probably to improve packing, storing and transportation.

Medication bottles tend to come in glass and plastic. During the interviews there was confusion around which medication bottles were packaged in plastic and which ones were glass. This resulted in larger variability in the data and difficulty in sense checking results as farms could either be underreporting or using a larger proportion of glass bottles.
Generally, smaller bottles (<100mL) are more likely to be glass whilst larger bottles (>500mL) are more likely to be plastic.

2.2.3 Medication Equipment

Medication equipment makes up 10% by weight of all veterinary plastic waste. This corresponds to 5.8 tonnes/year of plastic sent to landfill.

Medication equipment consists of the equipment required to administer medications and their primary packaging. This includes medication guns, slapshot tubes, syringes and detectable needle cartridges. These are all reusable, except for some syringes.

2.2.4 Insemination Equipment

Insemination equipment makes up 41% by weight of all veterinary plastic waste making it the largest veterinary plastic waste by weight. This corresponds to 23.3 tonnes/year of plastic sent to landfill.

Insemination equipment consists of all veterinary plastic equipment used for insemination including semen collection bags, semen pouches, semen bottles and AI catheters. Most piggeries reported to inseminate between 4-7 times per sow a year and thus generate a large amount of AI catheters annually, which are single use.

In the interviews piggeries expressed that AI catheters are single use as the reusable options are hard and impractical to sanitize increasing the risk of infection in the sow.

2.2.5 Personal Protective Equipment (PPE)

PPE makes up 31% by weight of all veterinary plastic waste. This is the largest veterinary plastic waste by volume, second by weight corresponding to 17.7 tonnes/year of plastic sent to landfill.

PPE includes gloves, sleeves and earplugs. In the interviews many piggeries expressed that gloves are often overused as people may get multiple gloves for the next few hours and then throw them all even if unused.

2.2.6 Secondary Packaging

Secondary packaging makes up 6% by weight of all veterinary plastic waste. This corresponds to 3.6 tonnes/year of plastic sent to landfill.

Secondary packaging includes polystyrene boxes and bags mainly for packaging of AI catheters. Polystyrene boxes are used for the transportation of veterinary medicines and semen. These are reused internally only in some cases. Piggeries that reported reusing the boxes often said they would reuse the vet boxes to store semen internally.

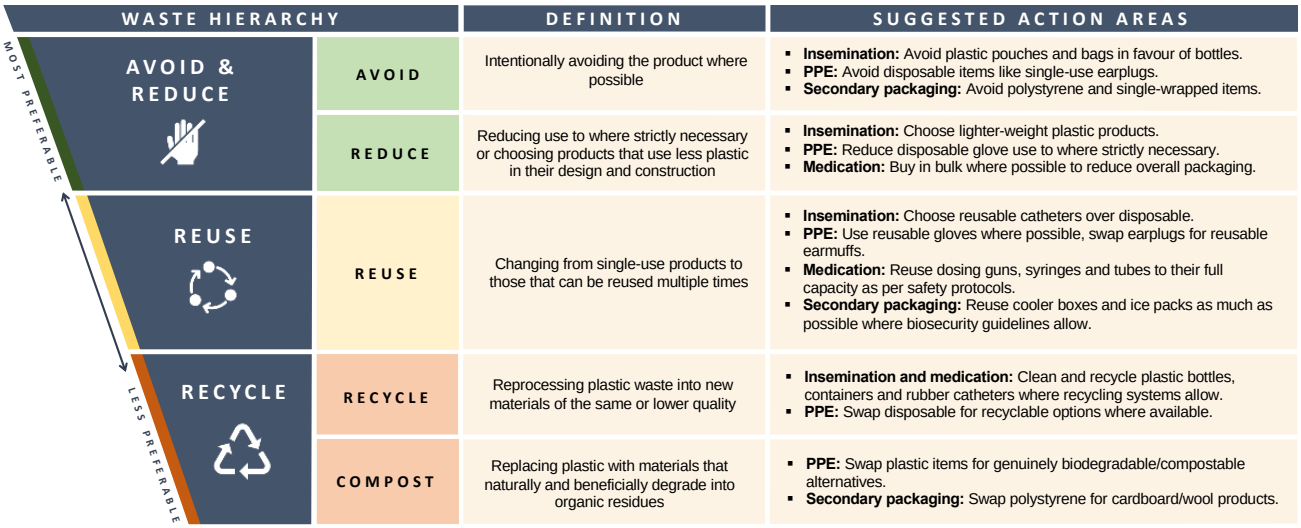
Concerns were expressed in using reusable boxes as this may pose a biosecurity risk if the boxes were reused in other sheds or piggeries.

3 Overarching Activities and Opportunities for improved management

3.1 Overview

A desktop review on the management of veterinary plastics and wastes from similar industries such as the medical industry is provided in Appendix C. The review investigates the potential for management practices, by plastic waste group (i.e. medication primary packaging, insemination), across the waste hierarchy based on national and international initiatives in the pork industry and other livestock industries and the medical industry.

Some of the action items identified in the desktop review against the waste hierarchy are provided in Figure 4-1.



WASTE HIERARCHY		DEFINITION	SUGGESTED ACTION AREAS
AVOID & REDUCE	AVOID	Intentionally avoiding the product where possible	▪ **Insemination:** Avoid plastic pouches and bags in favour of bottles. ▪ **PPE:** Avoid disposable items like single-use earplugs. ▪ **Secondary packaging:** Avoid polystyrene and single-wrapped items.
	REDUCE	Reducing use to where strictly necessary or choosing products that use less plastic in their design and construction	▪ **Insemination:** Choose lighter-weight plastic products. ▪ **PPE:** Reduce disposable glove use to where strictly necessary. ▪ **Medication:** Buy in bulk where possible to reduce overall packaging.
REUSE	REUSE	Changing from single-use products to those that can be reused multiple times	▪ **Insemination:** Choose reusable catheters over disposable. ▪ **PPE:** Use reusable gloves where possible, swap earplugs for reusable earmuffs. ▪ **Medication:** Reuse dosing guns, syringes and tubes to their full capacity as per safety protocols. ▪ **Secondary packaging:** Reuse cooler boxes and ice packs as much as possible where biosecurity guidelines allow.
RECYCLE	RECYCLE	Reprocessing plastic waste into new materials of the same or lower quality	▪ **Insemination and medication:** Clean and recycle plastic bottles, containers and rubber catheters where recycling systems allow. ▪ **PPE:** Swap disposable for recyclable options where available.
	COMPOST	Replacing plastic with materials that naturally and beneficially degrade into organic residues	▪ **PPE:** Swap plastic items for genuinely biodegradable/compostable alternatives. ▪ **Secondary packaging:** Swap polystyrene for cardboard/wool products.

Figure 3-1: Waste hierarchy in the context of veterinary plastics in pork production.

From the desktop review, there were reoccurring themes for interventions that applied across plastic group:

- **Education** is a key aspect of behaviour change and can be linked to most intervention options to increase the chances of success.
- **Partnerships** and collaboration between industry society and the scientific and policy maker communities will exceed single industry pursuits through sharing of common goals, knowledge and resources.
- **Influence** up the supply chain is key in the circular economy as suppliers and manufacturers are key partners to eliminate veterinary plastic waste.

These three themes and their importance in solving veterinary plastic waste are further explored in the following sections.

3.2 Education

Most of the pathways to plastic reduction detailed in this report rely to some extent on changing producer behaviour and practices. One of the most effective and simple ways to reduce plastic to landfill is to create an education and awareness program for pork producers and their staff, to help them identify and eliminate unnecessary plastics. An education campaign could be framed around the waste hierarchy and include collaboration or partnerships with advocacy organisations mentioned in this report.

Example actions include:

- **Avoid and reduce** – PPE is possibly the largest target for plastic reduction through education. Producers can be encouraged to change their behaviour around the excessive use of disposable gloves, their use of disposable over reusable items, and their choices when purchasing PPE products.
- **Reuse** – A key point highlighted in engagement was the willingness of some producers to choose reusable items, if they had the knowledge and ability to safely and efficiently clean and sterilise them. Reuse education could raise awareness on standard safety protocols, risks and procedures. It could also highlight some of the potential financial benefits of reusing equipment over continuously purchasing new equipment.
- **Recycling** – The crucial step in promoting recycling among producers is education on what can be recycled, how, and where. Producing recycling guides for common items detailing cleaning and preparation needs, benefits, and locations of recycling services could help encourage producers to increase their recycling. An education campaign could also encourage producers to investigate preferential purchasing recyclable alternatives over common disposable items.

There are multiple effective waste education campaigns that can be looked to as examples. These include veterinary industry education programs from Vet Sustain and Vets for Climate Action, as well as examples from the human medical industry like the 'Gloves are Off' campaign from the Great Ormond Street Hospital in the United Kingdom. Appendix D outlines examples of educational materials that could form a campaign targeted at reducing waste.

3.3 Partnerships

The problem of plastic waste is too large for any industry or group to tackle in isolation. Given the scale of plastic supply chains, the extent of disposable plastic use, and the cost and convenience barriers to alternatives, effective plastic reduction will require cooperation between industry, society, the scientific and policy-maker communities[4]. There are opportunities for the pork industry to tackle veterinary plastic waste through innovative partnerships across these stakeholder groups, for example, to change plastic-intensive practices or implement effective reuse or recycling by collaborating with recycling or recovery companies, or sustainability advocacy organisations. In doing so, the pork industry could become a leader in developing new solutions for plastic veterinary waste in animal production.

3.3.1 Collaborating for Avoidance and Reduction

Coordinated education and awareness-raising are key to encouraging behaviour change to reduce plastic to landfill. A number of national and international organisations promote and advocate for

[4] Lampitt, R.S., Fletcher, S., Cole, M., Kloker, A., Krause, S., O'Hara, F., Ryde, P., Saha, M., Voronkova, A., Whyle, A. 2023, *Stakeholder alliances are essential to reduce the scourge of plastic pollution*, Nature Communications Vol. 14, accessed 07/09/2023 from <https://www.nature.com/articles/s41467-023-38613-3>

plastic reduction in the veterinary industry, and could be approached for opportunities to collaborate, develop and share education resources.

These organisations include:

- Vets for Climate Action is an Australian organisation with a mission to mobilise the veterinary profession to tackle the climate crisis within and beyond the sector[5]. They represent veterinarians, vet nurses, practices and industry partners across Australia and work to educate and engage people on climate action and practices to reduce greenhouse gas emissions. Their resources include education-focussed webinars and articles. They have also developed a Climate Care Program aimed at enabling those in the veterinary industry to integrate environmentally sustainable solutions into practice[6].

3.3.2 Collaborating for Reuse

Cleaning and sterilising equipment for reuse – known as equipment reprocessing – is common in both human and animal medical industries, and there are many companies offering equipment and services to facilitate this. Two options for reprocessing medical equipment are to purchase equipment to perform sterilisation on-farm, or sending equipment to an external reprocessor.

Some examples of these are:

- **Melag** is a global company specialising in instrument reprocessing technology. They produce a range of systems for sterilising veterinary equipment that could potentially be implemented on-farm or in veterinary practices. For example, their washer-disinfector unit provides cleaning, disinfection and drying for medical products, and may be suitable for some applications in pork veterinary medicine, potentially reducing the time and labour to reuse certain items.[7]
- **Whiteley** is an Australian company manufacturing cleaning and disinfection products for a wide range of industries including the veterinary industry.[8] They offer an extensive range of products including instrument disinfectants and sterilants that meet the high standards of the human medical industry. A company such as Whiteley may be approached to develop disinfectants for veterinary items in the pork industry, tailored to the industry's needs.
- **Sterequip** is an external reprocessor of human medical equipment with reprocessing centres in five states of Australia. They perform sterilisation of reusable medical equipment and offer and delivery service and turnaround time of the next working day.[9] While this service is for human medical equipment, there may be potential to work with a company such as Sterequip, along with the broader veterinary industry community, to enable a similar system for veterinary equipment reprocessing.

Collaborating for reuse could also include working with research and development organisations to produce simple and cost-effective solutions for on-farm cleaning and sterilisation of medical equipment.

3.3.3 Collaborating for Recycling

Many recycling companies collaborate across industries to secure feedstocks for their recycling operations. Higher-value plastics such as HDPE containers are more sought-after by recycling companies than low value plastics like packaging films.

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5 Vets for Climate Action 2023, *About Vets for Climate Action*, accessed 13/09/2023 from <https://www.vfca.org.au/about>

6 Vets for Climate Action 2023, *The Climate Care Program by Vets for Climate Action*, accessed 13/09/2023 from <https://www.vfca.org.au/climatecare>

7 Melag 2023, *Washer Disinfectors for Practices and Clinics*, accessed 13/09/2023 from <https://www.melag.com/en/products/washer-disinfector>

8 Whiteley 2023, *We are Whiteley*, accessed 28/09/2023 from <https://www.whiteley.com.au/about-us/#who-we-are>

9 Sterequip 2023, *Sterequip is the right choice in reprocessing*, accessed 13/09/2023 from <https://sterequip.com.au>

A range of options for partnerships for recycling exist, including:

- **Agsafe** manages the DrumMUSTER national container recycling scheme for eligible farm chemical and animal health product containers. Agsafe is an industry-led non-profit organisation committed to product stewardship and ensuring the safe transport, storage and handling of agricultural and veterinary chemicals throughout the supply chain.40 Some pork producers expressed challenges with the current DrumMUSTER scheme as some containers are eligible and others are not, creating confusion amongst producers as well as a need to separate their containers for recycling. There may be an opportunity for discussion or collaboration with Agsafe to expand the range of high-value plastic containers eligible for the program, or otherwise find ways to ensure pork producers can easily access the program.
- **Recycling companies such as Veolia and Cleanaway** offer collaborative waste solutions for a wide range of industries. These companies invite interest from players in the agriculture industry to discuss specific needs, challenges and solutions for dealing with many types of waste, including plastics. A benefit of a partnership such as this is that large recycling companies are developing a broad national network of recycling infrastructure and have established systems for managing, transporting and processing plastic waste.
- **Planet Protector Packaging and Compostable Alternatives SA** are examples of companies which offer recyclable or compostable alternatives to disposable items such as compostable gloves commonly used by pork producers (See Section 5.3 for case study). They both invite collaboration from other companies and industries to design and supply products that meet specific needs.
- **Terracycle** actively seeks partners to collaborate on recycling solutions for a wide range of items. They offer partnerships in setting up public drop-off points for waste, which may be useful for veterinary practices working within the pork industry who could as drop-off locations for some of the plastic waste used on-farm.[10] They also invite collaboration from businesses with small to large amounts of plastic waste that aren't typically recyclable. For example, a partnership between animal health business Zoetis and Terracycle saw a national syringe-recycling initiative set up for a common medication delivered in the dairy industry.[11]

3.4 Influence Upstream of the Supply Chain

A major challenge for the pork industry in reducing plastic waste lies in the fact that producers are somewhat dependent on product manufacturers and suppliers for the quantity and type of plastic they must manage on-farm. Multiple examples of this issue arose during engagement with producers. For example, medications often come with additional delivery tubes that are not needed. Single use insemination catheters, as well as semen pouches, are manufactured using compound or laminated plastics that are not recyclable. Medication and equipment are often delivered with excessive packaging, such as single-wrapped items. These plastics represent a burden on producers that has multiple potential impacts. Producers must bear the costs of disposal of this waste, as time, labour and waste management fees. Inappropriate disposal of waste, such as burning or burying, can have severe environmental impacts over time.

This challenge presents an opportunity for the pork industry to leverage their influence and encourage product manufacturers and suppliers to improve the sustainability of their practices. This would ultimately benefit both producers and the environment. For example, manufacturers of catheters and semen pouches could be encouraged to produce items that are made from a single, recyclable type of plastic.

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[10] Terracycle 2023, *Partner with us*, accessed 13/09/2023 from <https://www.terracycle.com/en-AU/about-terracycle/partner_with_us>

[11] Vet Practice Magazine 2022, *Zoetis launches recycling initiative to support dairy farmers in the fight against waste*, accessed 13/09/2023 from <https://www.vetpracticemag.com.au/zoetis-launches-recycling-initiative-to-support-dairy-farmers-in-the-fight-against-waste/>

Suppliers could be notified that excessive packaging is not welcome, and that reuse options are preferred. Through advocacy and education, producers can also be encouraged to 'vote with their dollar' or choose products and brands whose sustainability practices align with their waste-reduction values.

3.4.1 Product Stewardship Schemes

Product stewardship acknowledges that manufacturers and suppliers have a responsibility for managing the environmental and human health impacts of their products, throughout the product life cycle and across the supply chain.[12] Product stewardship focuses on improving product design and manufacturing, encouraging the use of materials that can be easily and beneficially recovered or recycled, and implementing systems to recover product wastes such as packaging. Extended producer responsibility (EPR) is a form of product stewardship. EPR places financial responsibility for post-consumer collection, recycling and disposal of products on the producer of the product.[13]

Product stewardship aligns with the principles of a circular economy – aiming to design out waste, keep materials in use and regenerate natural systems.

The pork industry could use its influence to encourage better product stewardship of veterinary plastic products and wastes. There are a range of examples listed by the Product Stewardship Centre of Excellence where schemes are operating across the agriculture industry, however veterinary plastics are an underrepresented area and demonstrate room for improvement. Some examples of current schemes are included below.[14]

- **Agsafe** facilitates multiple product stewardship schemes, include ChemClear, for disposal of agricultural chemicals; DrumMUSTER for the recovery of chemical and medical containers; and BagMUSTER, under development for the recovery of plastic agricultural bags.
- **The Big Bag Recovery** is a collection and recycling scheme for large plastic agricultural sacks and bags that operates nationally.
- **Dairy Australia** is developing and implementing a product stewardship scheme for dairy silage wrap and farm plastics.

[12] Product Stewardship Centre of Excellence 2023, *What is Product Stewardship?,* Accessed 03/10/2023 from <https://stewardshipexcellence.com.au/product-stewardship/>

[13] Florin, N, Talwar, S & Read, R 2023, *Evaluating product stewardship benefits and effectiveness,* Department of Climate Change, Energy, the Environment and Water, Australian Government.

[14] Product Stewardship Centre of Excellence 2023, *Product Stewardship Gateway*, accessed 03/10/2023 from <https://gateway.stewardshipexcellence.com.au>

4 Intervention options longlist

4.1 Overview

This Chapter 5 summarises interventions that were identified in the desktop review (Appendix C) and considered applicable to the pork industry. This longlist was consolidated based on a workshop with APL.

A key to the subsequent tables described in Chapter 5 is provided in Table 5-1. This includes a description of each heading and the options that were considered for analysis.

Table 4-1: Key and description of parameters used to analyse intervention options.

WASTE GROUP	TYPE	PLASTIC TARGET	TIME	WH
Waste group refers to the grouping by utility of the plastic target: ▪ All veterinary plastic waste ▪ Medication primary packaging ▪ Medication equipment ▪ Insemination ▪ PPE ▪ Secondary packaging	Type refers to the intervention option type: ▪ Investigation ▪ Partnership ▪ Education and behaviour change ▪ Reinforcing existing practice ▪ Research and development ▪ Extended Producer Responsibility Schemes	Plastic target refers to the plastic that is targeted in the intervention option. The list is as per Appendix A.	Time refers to the indicative timeframe in which an intervention option could be implemented: ▪ <1 year ▪ 2- 5 years ▪ > 5 years	WH refers to the Waste Hierarchy: Avoid and reduce Reuse Compost and recycle

Intervention options are considered in the following sections for:

(i) APL

(ii) Suppliers and manufacturers and

(iii) Piggeries.

4.2 Intervention options for APL

4.2.1 Option Assessment

The intervention options for APL are provided in Table 5-2. These options focus on education and behaviour change and partnerships that will lead to avoidance, reduction, reuse and recycling of veterinary plastics.

Table 4-2: Intervention options for APL

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
All veterinary plastic waste 	Engage with pharmaceutical industry groups (e.g. Animal Medicines Australia) to understand interest in tackling veterinary plastic waste and investigate their capacity to change systems, redesign and develop container deposit schemes.	Partnership	All veterinary plastic waste	< 1 year		▪ Longer term solution ▪ Opportunity for change to impact other animal industries (where medications are common) ▪ Partnering provides more leverage to influence manufacturing/supply	▪ Prioritisation of other sustainability/waste issues over veterinary plastics ▪ Difficulty in convincing large manufacturing/supply companies
	Engage with other livestock industry groups (e.g. MLA) to understand interest in tackling veterinary plastic waste by seeking pathways for reuse and recycling alternatives jointly.	Partnership	All veterinary plastic waste	< 1 year		▪ Longer term solution ▪ Opportunity for change to impact other animal industries (where medications are common) ▪ Partnering provides more leverage to influence manufacturing/supply	▪ Prioritisation of other sustainability/waste issues over veterinary plastics ▪ Difficulty in convincing large manufacturing/supply companies ▪ Perceptions around biosecurity risk

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	Recycling guidelines presented in different education materials	Education and behaviour change	All veterinary plastic waste	< 1 year		▪ Strong precedent in other industries ▪ Simple and fast to implement ▪ Possible to set targets into effective campaign	▪ Requires a recycling collection system, ▪ Maintaining changed practices/behaviour
	Reuse guidelines presented in different education materials	Education and behaviour change	All veterinary plastic waste	< 1 year		▪ Strong precedent in other industries ▪ Simple and fast to implement	▪ Perceptions around hygiene/sanitation risk ▪ Perceptions around biosecurity risk ▪ Maintaining changed practices/behaviour
	Waste reduction education presented in different education materials	Education and behaviour change	All veterinary plastic waste	2-5 years		▪ Top of waste hierarchy ▪ Strong precedent in other industries ▪ Simple and fast to implement ▪ Possible to set targets into effective campaign	▪ Ingrained behaviour and resistance to change ▪ Perceptions around hygiene/sanitation risk ▪ Perceptions around biosecurity risk ▪ Maintaining changed practices/behaviour
Insemination 	Collaborate with companies focusing on instrument reprocessing technology to evaluate if they could develop an instrument for catheter sterilisation to be used in the pork industry or beyond (e.g. Melag, Whitley, Sterequip)	Partnership	AI catheter	> 5 years		▪ Longer term solution ▪ High priority as largest volumes of waste	▪ Cost of research and development ▪ Purchase cost of technology for producers ▪ Time and labour cost of sterilising catheters ▪ Difficulty in convincing large manufacturing/supply companies ▪ Perceptions around hygiene/sanitation risk

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
Medication primary packaging 	Explore hindrance of current lack of collection system for containers and enable participation through information, engagement and logistic (DrumMUSTER or complimentary)	Reinforcing existing practice	Bottles	2-5 years		▪ Strong precedent (DrumMUSTER) ▪ Existing recycling market for HDPE	▪ Time and labour cost of cleaning and separating containers ▪ Success depends on local availability/accessibility of service ▪ Transport and logistics required with associated costs
	Education to piggeries on the DrumMUSTER Scheme on what drums are accepted and how to use the service	Education and behaviour change	Bottles	< 1 year		▪ Simple and fast to implement ▪ Existing transport and logistics systems	▪ Success depends on piggeries adoption and local availability/accessibility of service ▪ Ingrained behaviour and resistance to change
Medication equipment 	Run an education campaign to reduce unnecessary use of disposable gloves	Education and behaviour change	Gloves	< 1 year		▪ Top of waste hierarchy ▪ Can be integrated to reuse guidelines or biosecurity comms ▪ Cost savings in PPE and waste disposal/incineration ▪ Strong precedent in other industries ▪ Simple and fast to implement	▪ May discourage use of gloves ▪ Ingrained behaviour and resistance to change ▪ Perceptions around hygiene/sanitation risk ▪ Perceptions around biosecurity risk
	Establish syringe recycling in partnership with syringe manufacturers/Suppliers (e.g. Terumo, Zoetis)	Partnership	Syringes	2-5 years		▪ Reduced costs in waste disposal/incineration	▪ Ingrained behaviour and resistance to change ▪ Time and labour cost of cleaning and separating syringes

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	(e.g. dairy, beef industry)						▪ Success depends on local availability/accessibility of service
Secondary packaging 	Investigate EPS alternative & pork specific packaging that is reusable or compostable (e.g. Planet Protector Packaging or APCO)	Research and development	Expanded polystyrene	2-5 years		▪ Non-plastic alternatives exist ▪ Manufacturers of alternatives can customise products ▪ Reduced costs in waste disposal/incineration	▪ Success depends on product manufacturers/suppliers ▪ Ingrained behaviour and resistance to change ▪ No precedent ▪ May have higher cost
	Understand the biosecurity risks of reusable eskys and what could be done to mitigate risk (e.g. boot baths, etc.)	Research and development	Expanded polystyrene	< 1 year		▪ Reduced costs in waste disposal/incineration ▪ Existing practice in some piggeries	▪ Perceptions around biosecurity risk ▪ Ingrained behaviour and resistance to change
	Develop partnerships with recyclers to recycle specific materials in areas with large production of plastic waste	Partnership	Packaging wraps	2-5 years		▪ No practice change ▪ Longer term solution	▪ Requires a recycling collection system ▪ Time and labour cost of cleaning and separating containers ▪ Success depends on local availability/accessibility of service

4.2.2 *Key Issues*

The key issues common to most options is that there may be resistance to practice change and there may be real or perceived competing objectives with other priorities such as hygiene of staff and biosecurity. However, competing objectives are regularly at play and staff at piggeries can be reinforced to for example use gloves for certain duties but to be mindful to not overuse them.

Also, for all the interventions that identify recycling as an option if there is no recycling collection and service, none of those options are possible. Beyond this, recycling needs to be transparent and lead to useful products made of recycled materials.

4.3 *Intervention Options for Suppliers and Manufacturers*

4.3.1 *Option Assessment*

The intervention options for suppliers and manufacturers are provided in Table 5-3. The type of intervention options focus on R&D and EPR schemes as suppliers and manufacturers have the opportunity to change the design of products and services to make them more circular. These can be designed to be reused or more easily recycled as well as redesigning the machinery associated with reuse and recycling.

Table 4-3: Intervention Options for suppliers and manufacturers

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
All veterinary plastics 	Establish the use of recycled plastic in medication primary packaging or medication equipment	Research and development	None	2-5 years		▪ Genuine recycling requires all industries where possible to utilise recycled plastic	▪ May be challenging with quality standards and product requirements ▪ Difficulty in convincing large manufacturing/supply companies
Insemination 	Develop a safe and efficient way of sterilising catheters to enable safe reuse	Research and development	AI catheter	> 5 years		▪ Catheters were once reusable ▪ Cost savings in catheters and waste disposal/incineration ▪ High priority as largest volumes of waste	▪ Time and labour cost of cleaning catheters ▪ Possibly more expensive than disposable in the short term ▪ Perceptions around hygiene/sanitation risk

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
Medication equipment 	Change medication bottle design to stop the attached slap tubes and order the slap tubes as a separate item to encourage reuse	Research and development	Slapshot tubes	2-5 years		▪ Small number of companies to target	▪ Difficulty in convincing large manufacturing/supply companies
	Investigate the potential of increasing the availability of needle free vaccines	Research and development	Syringes	> 5 years		▪ Technology already exists for piglets and large pigs ▪ Reduces injury risk to workers ▪ Improved animal welfare ▪ Eliminates risk of carcass defects/product loss from needle abcesses/injuries ▪ Possibility of leasing equipment to reduce initial cost	▪ Large initial cost of equipment ▪ Ingrained behaviour and resistance to change ▪ Requirement for product support (repair, service, delivery etc.) in regional/remote areas
	Redesign syringes and other single-use plastic to be lighter (have less plastic)	Research and development	Syringes	> 5 years		▪ No change in behaviour	▪ Does not encourage waste reduction awareness/reuse behaviours ▪ Difficulty in convincing large manufacturing/supply companies
Medication primary packaging	Standardise the colour and plastic composition of medication bottles and lids so they are	Research and development	Bottles	> 5 years		▪ Small number of companies to target	▪ Requires a recycling collection system ▪ Success still depends on consumer behaviour (whether items are

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	more easily recyclable						recycled or disposed/incinerated) ▪ Difficulty in convincing large manufacturing/supply companies
	Investigate the options to expand the use of in feed and water medication for those medications used on a regular basis.	Research and development	Bottles	2-5 years		▪ Existing practice with established use ▪ Reduced costs in waste disposal/incineration	▪ Still requires packaging ▪ May contribute to over-medication ▪ May not be suitable for many medications ▪ Less certainty in medication delivery amounts
	Develop Producer Responsibility Schemes for medication bottles, syringes and other medical equipment	Extended producer responsibility Scheme	Medication primary packaging	> 5 years		▪ Shifts responsibility of waste to suppliers and manufacturers ▪ Small number of companies to target ▪ Existing examples in businesses with similar challenges (e.g. remoteness)	▪ Companies may require additional cost/levy on products to fund scheme (increased costs) ▪ Success still depends on consumer behaviour (whether items are recycled or disposed/incinerated) ▪ Difficulty in convincing large manufacturing/supply companies ▪ Large companies more likely to respond to consistent pressure from multiple animal production industries

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	Establish labelling of polymer type (e.g. 1-7) in medication equipment and packaging	Research and development	Medication primary packaging	2-5 years		▪ Simple and fast to implement ▪ Small number of companies ▪ No change in use behaviours	▪ Requires recycling collection system ▪ Success still depends on consumer behaviour (whether items are recycled or disposed/incinerated) ▪ Difficulty in convincing large manufacturing/supply companies
Secondary packaging 	Extend the use of compostable boxes that are insulative, lightweight and cost-competitive (e.g. TempGuard, Chilltainer & Woolpack)	Reinforcing existing practice	Expanded polystyrene	2-5 years		▪ Non-plastic alternatives exist ▪ Manufacturers of alternatives can customise products ▪ No change in producer behaviour ▪ Simple and fast to implement ▪ Reduced costs in waste disposal/incineration	▪ Success depends on product manufacturers/suppliers ▪ Ingrained behaviour and resistance to change ▪ May have higher cost ▪ No change in single use culture
	Replace single use ice packs with reusable/compostable canvas/other material	Reinforcing existing practice	Ice packs	< 1 years		▪ Non-plastic alternatives exist ▪ No change in producer behaviour ▪ Simple and fast to implement	▪ Time and labour cost of cleaning ▪ Hygiene/sanitation risk ▪ Initial cost of alternatives ▪ Ingrained behaviour and resistance to change
	Eliminate or reduce secondary packaging in catheters	Reinforcing existing practice	Packaging wraps	2-5 years		▪ Simplifies packaging ▪ Change is on the supply side so is more consistent across industry	▪ Difficulty in convincing large manufacturing/supply companies ▪ Hygiene/sanitation risk

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	Eliminate EPS packing peanuts and replace with available replacements (e.g. honeycomb wrap)	Reinforcing existing practice	Secondary packaging	< 1 years		▪ Identified by APCO as problematic and unnecessary SUP for immediate action, ▪ Simple and fast to implement, ▪ No change in producer behaviour, ▪ Non-plastic alternatives exist and are commonly used	▪ N/A

4.3.2 Key Issues

The key issues common to most options is that suppliers and manufacturers are likely to be slow to respond and may not have sufficient incentive to make changes. Products may be sold to many different countries with different standards that may lead to a lack of flexibility in manufacturing.

4.4 Intervention options for piggeries

4.4.1 Option assessment

The intervention options targeted at piggeries are provided in Table 5-4. These options focus on practical steps that can be taken to reuse existing products and start recycling veterinary plastic waste.

Table 4-4: Intervention options for piggeries.

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
All veterinary plastic waste 	Engage a recycling collection service and improve waste separation for recycling in piggeries by adding a recycling bin for recyclables.	Reinforcing existing practice	All veterinary plastic waste	< 1 years		▪ Providers are established ▪ Provides opportunity for waste education/awareness ▪ No change to purchase/use behaviours	▪ Time and labour cost of separating items ▪ Ingrained behaviour and resistance to change ▪ Success depends on local availability/accessibility of recycling services ▪ Confusion and lack of plastic types in products may lead to confusion on what is recyclable
Insemination 	Engage with boar stud facilities to understand reusable alternatives to semen pouches for delivery of semen	Investigation	Semen pouch	< 1 years		▪ Small number of companies to target ▪ Reduced costs in waste disposal/incineration	▪ Ingrained behaviour and resistance to change ▪ Time and labour cost of cleaning (items cannot be contaminated)
	Use insemination guns with larger pouches to reduce the use of pouches.	Reinforce existing practice	Semen pouch	< 1 years		▪ Time savings and efficiency ▪ No litter ▪ Small number of companies to target	▪ If semen is collected externally, it requires collaboration with the service provider ▪ Time and labour cost of cleaning guns ▪ Possibly more expensive than pouches in the short term

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
						▪ Reduced costs in waste disposal/incineration	▪ Ingrained behaviour and resistance to change
	Shift to reusable bottles rather than pouches	Reinforcing existing practice	Semen pouch	< 1 years		▪ Existing practice with established use ▪ Cost savings in pouches and waste disposal/incineration	▪ Favourable to farms that collect their own semen ▪ Time and labour cost of cleaning bottles
Medication equipment 	Increase reusable medication delivery with dosing guns	Reinforcing existing practice	Syringes	< 1 years		▪ Existing practice with established use, ▪ No change in purchase/use behaviours	▪ Extent of reuse may already be maximised as not all medications are used regularly enough to justify a medication gun
PPE 	Replace single use earplugs with reusable earmuffs (PPE for each staff)	Reinforcing existing practice	Ear plugs	< 1 years		▪ Simple and fast to implement ▪ No change in use behaviours	▪ Time and labour cost of setting up reuse system
	Replace single use gloves with reusable gloves for tasks that are not veterinarian and there is no risk of health implications for pigs or humans.	Reinforcing existing practice	Gloves	< 1 years		▪ May justify a better quality fit-for-purpose glove ▪ Wide choice of products available for different activities	▪ Risk of generating larger weight of waste if reuse rates are low ▪ Time and labour cost of cleaning ▪ Perceptions around biosecurity risk

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	Replace single use gloves with certified biodegradable gloves	Reinforcing existing practice	Gloves	< 1 years		▪ No change in behaviour	▪ Confusion around what materials are genuinely biodegradable and accepted in a compost bin ▪ Difficulty in finding a composting operation to receive waste ▪ Different product qualities from plastic ▪ No change in single-use culture ▪ Limited range of options on the market
	Develop a direct partnership with recycling company to recycle gloves and other PPE (e.g. Terracyle & RightCycle)	Partnership	PPE	2-5 years		▪ No change in behaviour	▪ Time and labour cost of cleaning (items cannot be contaminated) ▪ Requires collection/drop off points to be established ▪ Must ensure that recycling is transparent ▪ Doesn't discourage over-use
Secondary packaging 	Extend the use of reusable boxes that are insulative, lightweight and reusable with no risk to biosecurity.	Reinforcing existing practice	Expanded polystyrene	2-5 years		▪ Reduced costs in waste disposal/incineration	▪ Behaviours needed to address biosecurity risk ▪ Initial cost of alternatives ▪ Ingrained behaviour and resistance to change
	Maximise the reuse of EPS boxes internally for semen storage	Reinforcing existing practice	Expanded polystyrene	< 1 years		▪ Reduced costs in waste disposal/incineration ▪ Existing practice with established use	▪ EPS boxes have limited lifespan, ▪ Perceptions around biosecurity risk, ▪ Ingrained behaviour and resistance to change

WASTE GROUP	INTERVENTION OPTION	TYPE	PLASTIC TARGET	TIME	WH	STRENGTH	WEAKNESS
	Recycle expanded polystyrene if council provides the service.	Reinforcing existing practice	Expanded polystyrene	< 1 years		▪ Existing recycling market ▪ Council MRF's and RRC provide drop-off	▪ Not all councils provide the service ▪ Must ensure that recycling is transparent ▪ Doesn't discourage over-use

4.4.2 Key issues

The key issues identified relate to the biosecurity risks and practice change required to be able to reuse items on farm. Piggeries located in remote areas are unlikely to have a recycling collection service which is a bottle neck for all intervention options that look at recycling.

5 Option case studies

5.1 Overview

Intervention options were selected for detailed analysis based on a workshop with APL. Only intervention options that could be implemented in the short-term by piggeries were selected.

The intervention options developed into case studies are:

- Separation and collection of bottles and syringes for recycling
- Replacing single-use gloves with certified biodegradable gloves
- Bulk insemination with insemination gun.

Each case study quantifies the amount of veterinary plastic that could be diverted from landfill, incineration or on-farm burial for a 500 sow piggery if the proposed intervention is executed. There are also details on the practicalities of implementing the option with caveats and options based on the size of the piggery. Each case study finishes with further considerations for piggeries to further contextualise the case study to their operations.

5.2 Case Study 1: Separation and Collection of Bottles and Syringes for Recycling

Why?

Establishing a collection and recycling service could lead to a rapid diversion of recycling material to landfill. Many of the plastics used in veterinary plastics such as HDPE and PET have an established recycling market that are currently not being maximised. However, the biggest barrier for piggeries is the lack of access to conventional recycling collection.

Medication bottles and syringes are likely to be the material group which is the most recyclable, based on the plastic type and current recycling markets. Other veterinary plastics can be recycled but they are either made of low-grade plastics (e.g. polystyrene boxes), composite plastics (e.g. medication guns) or are likely to be highly contaminated (e.g. catheters and slapshot tubes). Based on the data collected in the interviews, **an average farm of 500 sows landfills 299 medication bottles and 371 syringes annually.** This is equal to 15 kg of plastic waste. This farm would require approximately 240- litres of bin space annually to accommodate this collection, which could be broken down into two collections of 120- litre bins. If other recycling material is identified from offices this can be incorporated into the collection process.

Terracycle Collection Service – PPE[1]

Terracycle has a program called Zero Waste Box where you purchase a zero waste box for PPE and it is delivered by mail to your location. This can then collect ear plugs, disposable face masks, disposable gloves, safety glasses and disposable garments. When the box is full the box comes with a pre-paid return label so that you can post it back to them. A medium size box (28cmx28cmx95cm) costs $402 per box.

How?

Piggeries could look at two models of collection and recycling systems. The first would be for piggeries to find the closest material recovery facility (MRF) or equivalent and drop off waste. This would be applicable to all piggeries and as the recycling materials are not perishable this duty can be done between 2 and 4 times a year. Alternatively, a waste collection service to a recycling facility can be arranged. However, for these small loads, it is unlikely unless there is a collection nearby. Both of these options will be described below:

Waste Collection Service

Based on the pricing system of waste management companies it is hard to get an indicative price for a certain volume of recycling waste. The pricing system depends on existing customers nearby and distance to a recycling centre, amongst other factors.

The steps required to establish this system are provided in Figure 6-1.

Figure 5-1: Steps to start a waste collection service.

Drop Off Recycling

In the situation where a recycling collection service is cost prohibitive, farms can look at the closest recycling centre that can take the waste. This may be some distance from the farm but it is likely that staff or a veterinarian may be able drop off if they are going in the direction of a town with a drop off point. This can include a financial incentive.

The steps required to establish this system are provided in Figure 6-2.

Figure 5-2: Steps to set up a drop off system.

For further information on drop off locations:

- Website to find recycling drop off locations for businesses developed by Planet Ark in partnership with NSW EPA: https://businessrecycling.com.au
- Interactive map of Victoria with waste providers: https://mapshare.vic.gov.au/webmap/recyclingvictoriainfrastucturemap/

Further considerations

Farm waste management and collection systems for plastics are gaining momentum, especially with the research and recommendations for an Australian National Agricultural Plastics Stewardship Scheme.[15] The logistical challenge of transporting waste to recyclers may be prohibitive now due to cost or operations but may change as new collection services are established. Piggeries should find the collection system that is most fitting to the operation.

This could include:

- Investigate other collection systems in your area
- Work out the best location to set up the collection bins
- Decide on the biosecurity risks and precautions of having bins and a collection service. Drop off locations further from the sheds can be arranged to reduce risks so trucks don't enter the property
- Decide on the collection infrastructure bins. This could include cages or bins, labels or if the area will be floored and roofed.
- Communicate the intent of setting up a collection system with Council and other farms in the area.

5.3 Case Study 2: Replacing Gloves with Certified Biodegradable Gloves

Why?

Certified biodegradable/compostable alternatives to plastic disposable gloves are available and could be the first step in reducing waste generated and removing plastic from landfill. Based on the interviews, **an average farm of 500 sows landfills approximately 4,500 nitrile powder free gloves annually.** This is equal to 22 kg of plastic waste. If these were certified biodegradable they will breakdown into carbon dioxide, water and other organic compounds in composting conditions. Whilst composting would be the ideal destination, regardless of how they are disposed of, the gloves will eventually biodegrade and not cause any long-term contamination.

[15] RMCG 20232, 'National Agricultural Plastics Stewardship Scheme – Update', https://mcusercontent.com/166f825683dac6076c85fab74/files/d8409160-888d-485f-cde7-b06e7b0a5249/DAWE_NPSIF_ag_plastic_waste_update_20230526_lr.01.pdf

Key terms:

- **Biobased plastics** are plastics that are made from renewable resources (i.e. biomass). Example: bioPE, PLA.
- **Biodegradable plastics** are plastics that can be broken down by biological organisms into its building blocks (i.e. monomers). Example: PBAT, PLA, PHAs, starch and cellulose.
- **Compostable plastics** are biodegradable plastics that in a reasonable timeframe under composting conditions are broken down by biological organisms into carbon dioxide, water, heat and other small organic compounds. This means that all compostable plastics are biodegradable but not all biodegradable plastics are compostable. Example: PBAT, PLA, PHAs, starch and cellulose that can breakdown under composting conditions in a reasonable timeframe.
- **Certified compostable plastics** are compostable plastics that in Australia are certified under the following Australian Standards:
    - AS 4736-2006 Biodegradable plastics - Biodegradable plastics suitable for composting and other microbial treatment
    - AS 5810-2010 - Biodegradable plastics - Biodegradable plastics suitable for home composting.
    - Example: AS5810 certified gloves made of PLA and PBAT.

How?

Swapping the type of gloves could be a quick win for the pork industry as it is a simple transition as one product is replaced with another without a disruption to normal operation in piggeries. The availability of alternatives and ease of implementation means that more piggeries are likely to pick this up.

Although deceivingly simple, the terms biodegradable and compostable has caused a lot of confusion to consumers and waste managers. The terms are ambiguous given that the timeframe and conditions in which biomass-based polymers biodegrade or compost are not specified. These are often rejected in composting facilities as they are hard to tell apart from plastic contamination and will not break down in the required timeframe. Therefore, when selecting recyclable or compostable alternatives to plastic gloves select the Australian Standards certification Home compostable (AS5810) and Industrially compostable (AS4736).

A comparison of different biodegradable gloves and the cost difference in a year for a farmer of 500 sows is provided in Table 6-1.

Table 5-1: Compostable gloves in the market.

DETAILS	BAU	BIOPAK	COMPOSTABLE ALTERNATIVES	GLOVEON
Visual example				
Home compostable - AS5810	-	Yes	Yes	No
Industrially compostable AS4736	-	Yes	Yes	No
Landfill compostable	-	Yes	Yes	Yes
Cost of 10 boxes of 100 units (1000 gloves)	$62.	$59.5	$136.4	$115.5
Cost of gloves for a year in an average medium farm	$276.8	$265.6	$ 608.9	$515.6
Percentage difference	NA	- 4%	120%	85%

Images left to right:

- *BioPak, Medium Compostable Glove, https://www.biopak.com/au/medium-compostable-glove , (accessed 28/11/2023)*
- *Compostable Alternatives, Food grade home compostable disposable gloves, https://www.compostablealternatives.com.au/product/disposable-gloves/ (accessed 28/11/2023)*
- *MUN, Avalon Biodegradable Nitrile Exam Gloves, https://munglobal.com.au/product/avalon-biodegradable-nitrile-exam-gloves/ , (accessed 28/11/2023)*

Further considerations

It is likely that as the bioplastic market matures, the cost for these products will reduce. In the meantime, piggeries interested in implementing this option could run trials to gauge the fit-for-purpose properties of the different gloves. This could include the following:

- Try different brands to understand performance and sizing
- Work out the best location to place glove boxes to minimise overconsumption
- Decide the on-farm collection infrastructure of the gloves, mostly bins. This could be the general bin or a labelled biodegradable glove bin if this will be processed separately
- If there is a composting pile for manure or bedding on farm trial in an area the incorporation of the compostable gloves. If successful incorporate into the feedstock. Assess the implication of having compostable gloves as an input if selling the product within a standard.
- Investigate local collectors and processors ability and willingness to compost gloves.

5.4 Case Study 3: Bulk Insemination with Insemination Gun

Why?

Insemination equipment makes up the largest veterinary plastic group by weight. **A typical farm of 500 sows landfills approximately 2,400 semen pouches. This is equal to 9 kg of plastic waste.** Pouches are made from multilayer plastics and usually store between 60ml to 90ml of semen. The pouches are usually made from polyethylene terephthalate (PET), laminating adhesive and

polyethylene (PE). Despite the advantages achieved with the use of multilayer films, the recycling of these is a challenging task as the films have to be delaminated prior to recycling.

How?

An emerging technology in the industry are insemination guns. Like medication guns, these guns draw semen from a bulk bag with volume and speed settings completely avoiding the semen pouches. This could reduce plastic waste by 2/3 as larger plastic bags have a lower plastic to volume stored ratio (See Calculation).

If in the future the semen gun could be attached to a bottle to be washed and reused, this would lead to altogether eliminating soft plastic for this purpose.

Calculation:

- 80mL pouch has dimensions of approximately 6cm x 19cm (114cm2) which equates to 1.43cm^2/mL
- 3L semen bag has dimensions of approximately 53cm x 22.5cm (1192.5cm2) which equates to 0.4cm^2/mL.
- Per millimetre of semen the pouch uses more than three times the amount of plastic.

Note: These are rough estimates and the thickness of the plastic was assumed to be constant.

Insemination guns are not readily available in Australia. Approximate costing for the insemination gun against the semen pouches is described in Table 6-2.

Table 5-2: Insemination gun costing

DETAILS	BAU	INTELLIMATE BULK INSEMINATION SYSTEM
Visual example		
Cost of the gun	-	$2,819
Cost of the gun with backpack and adapter	-	$2,895
Plastic bags (approx. 1900ml 400 pack)	-	$1,410
Semen Pouches (60 ml 750 roll)	$143	-
Semen pouches (90ml 750 roll)	$175	-
Cost per 1000 ml of semen stored	$0.33	$0.19
Cost savings	-	- 42%

Images:

- *Intellimate Bulk insemination System by Genepro. Retrieved from: https://www.genepro-inc.com/product/intellimate-bulk-insemination-system/*

The above costing per volume of semen is high level. The bulk system insemination is viable based on the cost of pouches against larger semen bags. However, the economic viability will be specific to each farm and should also consider increase in insemination efficiency which may reduce labour costs on farm.

Further Considerations

The semen collection process, freezing and thawing is a complex process. Semen guns like the Intellimate bulk insemination system by Genepro (See Fig 1) are currently in the market. However, this is yet to be mainstream and how the process integrates with current farm practices may take a few iterations. Large bags may reduce the flexibility of how many sows are inseminated at one time or may lead to wasted semen. This may only be worth it for large commercial farms that are inseminating from frozen or medium farms that are using fresh semen. Balancing the pros and cons in more detail specific to a farm will be the most appropriate to a farm.

Some things to take into account include:

- Determining the optimal volume of bag to serve your sow numbers with minimal semen wastage
- Understanding how the medication gun fits into the day-to-day operations (vendor will be able to provide insights)
- How does the gun fit into operations if the semen is being delivered externally. Will the boar studs be able to accommodate larger bags?

6 Conclusion

This project quantified the extent of veterinary plastic consumables that end up being disposed in landfill, incinerated or buried on farm in pork production. In total the industry is estimated to generate 58 tonnes of plastic waste a year from veterinary operations.

Further, this project has identified a longlist of intervention options for APL, veterinary consumables suppliers and manufacturers and piggeries to work towards reducing plastic waste in the industry.

The pork industry has been proactive in considering its management of waste and potential for resource recovery to progress a more circular production system. This project has highlighted that there is much opportunity for improvement and if options are implemented the redesign, reuse and recycling of veterinary plastic consumables may one day be commonplace.

For APL having a baseline will allow to track progress when interventions are being implemented.

Appendix A: Material list

Table A-0-1: Detailed list for data collection of each type, group and unit.

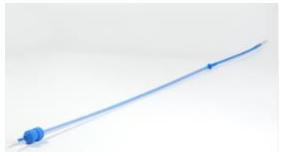
TYPE	GROUP	UNIT
Medication primary packaging	Bottles	Medication bottles - 50 ml
Medication primary packaging	Bottles	Medication bottles - 100 ml
Medication primary packaging	Bottles	Medication bottles - 250 ml
Medication primary packaging	Bottles	Medication bottles - 500 ml
Medication primary packaging	Bottles	Medication bottles - 1L
Medication primary packaging	Bottles	Bottles - 2L
Medication primary packaging	Bottles	Bottles - 5L
Medication primary packaging	Bottles	Bottles - 20L
Medication primary packaging	Bottles	Medication bottle caps
Medication primary packaging	Bottles	Medication bottle spray - 500 ml
Medication primary packaging	Vaccine packs	Vaccine packs
Medication equipment	Slapshot tubes/easing tubes/draw tubes	Slapshot tubes/easing tubes/draw tubes
Medication equipment	Dosing guns/medication gun/vaccinator	Dosing guns/medication gun/vaccinator
Medication equipment	Detectable needles 100/box - cartridges	Detectable needles 100/box - cartridges
Medication equipment	Syringes	Syringes - 1 ml
Medication equipment	Syringes	Syringes - 2 ml
Medication equipment	Syringes	Syringes - 5 ml
Medication equipment	Syringes	Syringes - 10 ml
Medication equipment	Syringes	Syringes - 20 ml

Medication equipment	Syringes	Syringes - 50 ml
Insemination	AI catheter	AI catheter
Insemination	Semen bag	Semen bag - 3L
Insemination	Semen bag	Semen bag - 5L
Insemination	Semen bottles	Semen bottles - 40 ml
Insemination	Semen bottles	Semen bottles - 60 ml
Insemination	Semen bottles	Semen bottles - 100 ml
Insemination	Semen pouch	Semen pouch
PPE	Ear plugs	Ear plugs
PPE	Gloves	Gloves
PPE	Sleeves	Sleeves
Secondary packaging	Expanded polystyrene	Expanded polystyrene - small
Secondary packaging	Expanded polystyrene	Expanded polystyrene - large
Secondary packaging	Ice brick/packs	Ice brick/packs
Secondary packaging	Packaging wraps	Packaging wraps

Appendix B: Material list and characteristics

Table A-2: List of examples used to guide data collection of each type and units.

TYPE	MATERIAL UNIT	DESCRIPTIONS	EXAMPLE	COLOUR RANGE	PLASTIC
Medication primary packaging	Medication bottles (50 ml – 1L)	Medication bottles tend between 50ml and 1L tend to hold: vaccines, anti-parasites, anti-inflammatories, etc.		Mostly clear, white or tinted brown.	PET and HDPE
	Bottles (2L – 5L)	Bottles tend to hold medications or adjacent used in bulk that are not perishable.		Mostly white or clear	HDPE
	Bottles - 20L	Bottles tend to hold sterilisation chemicals.		Mostly white or clear	HDPE
	Medication bottle caps	Lids tend to be nitrile or screw on.	N/A	N/A	Nitrile or PE (with aluminium)
	Medication bottle spray	Medication bottles used for anti-septics and other spray on products.		Varied but mostly white	Mostly HDPE

TYPE	MATERIAL UNIT	DESCRIPTIONS	EXAMPLE	COLOUR RANGE	PLASTIC
Medication equipment	Slapshot tubes/easing tubes/draw tubes	Connect medication bottle and dosing guns.		Clear	PVC, PET or HDPE
	Dosing guns/medication gun/vaccinator	Administers medications through injection in set doses. Usually one used per medication and is reused until faulty or broken.		Varied	N/A
	Detectable needles 100/box - cartridges	Needles attaches to dosing gun. Cartridges are plastic. Needles can be reused.		Red and clear	N/A
	Syringes (1 ml – 50 ml)	Used to deliver injections of medications not administered with the dosing gun.		Clear	HDPE
Insemination equipment	AI catheter	For insemination. Two types for guilts and sows. Guilts have an extra tube inside.		Varied	Foam or poly-gel tips PVC or Silicone rod
	Semen bag (3L – 5L)	Used to collect semen.		Clear	Mixed layers of plastic

TYPE	MATERIAL UNIT	DESCRIPTIONS	EXAMPLE	COLOUR RANGE	PLASTIC
	Semen bottles (40 ml – 100ml)	Used instead of pouches to dose deliver semen into the catheter. Mostly used in farms that collect their own semen.		Clear	LDPE
	Semen pouch	Used to deliver a set dose of semen into the catheter. Has a hard tip. Mostly used in farms that get semen delivered by service providers (e.g. PIC). Soft		Clear	Lamination of PET and PE Hard top
Personal protective equipment (PPE)	Ear plugs	Ear plugs used to protect workers from noise in piggeries.		Varied	Foam
	Gloves	Nitrile gloves used for animal handling and other duties on farm.		Light blue	Nitrile rubber
	Sleeves	Internal gloves used for assisting birth.		Light blue	Nitrile rubber

TYPE	MATERIAL UNIT	DESCRIPTIONS	EXAMPLE	COLOUR RANGE	PLASTIC
Secondary packaging	Expanded polystyrene boxes	Used to deliver temperature sensitive medications and semen.		White	Polystyrene
	Ice packs	Ice packs can be as seen on picture or multiple smaller one		White and blue	N/A
	Packaging wraps	Mostly used to wrap catheters either individually or in packs of multiple.		Clear	HDPE

Appendix C: Review of relevant management practices for veterinary plastics

C.1 Introduction

The waste hierarchy is a framework for managing waste in alignment with circular economy principles. It ranks strategies for dealing with waste in order of preference, with avoidance of waste as the most desirable choice and disposal to landfill as the least (Figure C-1). The waste hierarchy can be used to explore options for waste management in the pig industry and determine the best pathways to achieve holistic reduction in plastics, towards the goal of zero waste to landfill by 2025.

Avoiding plastics where they are not strictly needed is by far the best option for reducing plastic waste to landfill. Estimates show that less than 10% of all plastic ever produced has been recycled, and almost 80% has ultimately made its way to landfill.[16] This is despite the strong emphasis on recycling as a solution for plastics over the last 30 years. While recycling may seem like the simple option, plastics cannot be recycled infinitely, and are usually 'downcycled' into products of lower quality with the addition of virgin materials required through each pass of the recycling process. That being said, recycling of plastics that cannot be avoided or reused is preferable to disposal in landfill.

A holistic reduction in plastic waste requires focus on the most preferable options in the waste hierarchy – avoidance, reduction and reuse. For the pork industry, this means assessing current practices, identifying opportunities for behaviour change, and using industry influence to encourage the innovative design, manufacture and use of products that can be reused where feasible. Strong and encouraging efforts are being made to reduce plastic use across different industries such as the veterinary industry, animal production, and the human medical industry. Exploring the progress in these industries can provide helpful case studies and shed light on pathways to plastic reduction that the pork industry can both learn from and build upon.

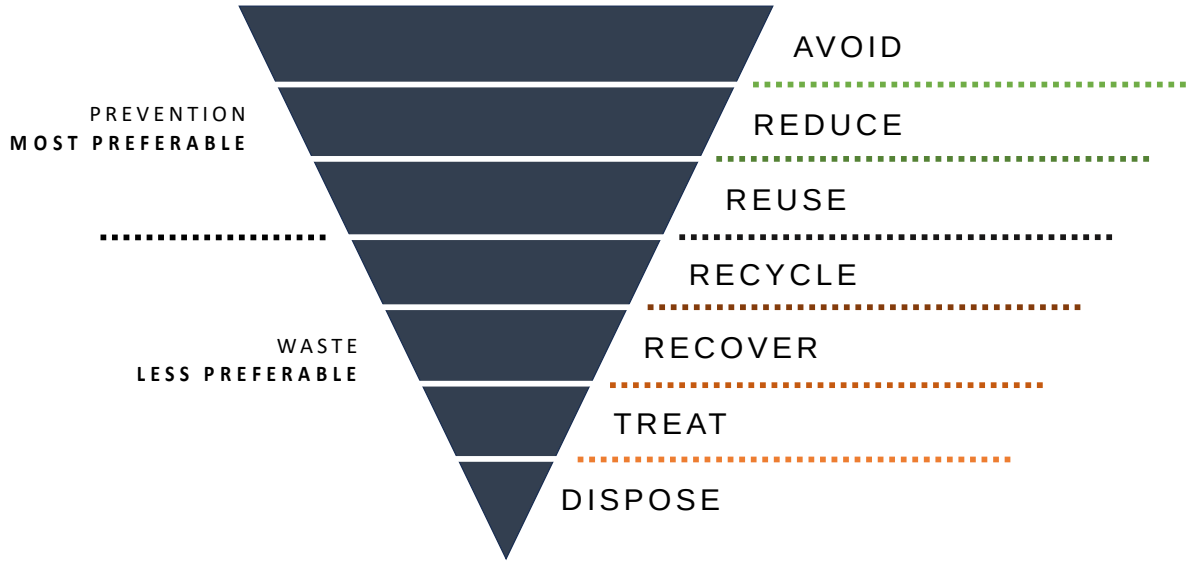


Figure C-1: Waste hierarchy triangle[17].

[16] Geyer, R et al, 2017, *Production, use and fate of all plastics ever made,* Science Advances vol 3, issue 7, accessed from <https://www.science.org/doi/10.1126/sciadv.1700782>

[17] Adapted from: Australian Government 2018, *National Waste Policy: Less Waste, More Resources*, accessed from <https://www.agriculture.gov.au/sites/default/files/documents/national-waste-policy-2018.pdf>; and

C.2 Insemination Equipment

ACTION	PRACTICES	ASSESSMENT
AVOID AND REDUCE 	▪ Avoid single-use items and laminated **plastic pouches** where possible ▪ Choose **lighter-weight products** to reduce overall plastic to landfill	
REUSE 	▪ Choose **reusable catheters** over single-use	
RECYCLE 	▪ **Clean and recycle** rubber catheters and plastic bottles where possible	

Achievable – simple and effective options are available or could easily be developed

Somewhat achievable – barriers may include cost, logistics or behaviour

Challenging – significant cost, logistical or behavioural barriers to change

Insemination equipment – semen bottles, bags, pouches and catheters – represent the largest source of plastic veterinary waste in the pork industry. These items comprise 40% of all veterinary pork plastic by number of items, and 41% by weight. In total, over 3 million or 13 tonnes of these items are disposed of in landfill or incinerated each year. Semen pouches and insemination catheters comprise the bulk of this stream at 1.3 million items each per year. This waste stream has possibly the largest environmental impact, and is the most complex to provide solutions for, due to the nature of the materials used.

Insemination equipment is problematic due to its typical plastic composition, its high degree of contamination with animal fluids, and the animal safety and cleanliness requirements placed upon it. For example, semen pouches are the most abundant item in plastic insemination waste, according to the data collected through interviews. The Australian Packaging Covenant Organisation (APCO) reports that flexible plastics, which includes plastic pouches, have the lowest recovery rate of all material categories.[18] Flexible plastics are difficult to recycle because they are lightweight and not suited to mechanical recycling systems, where they often become tangled in machinery and contaminate paper streams.[19] Flexible plastics such as pouches are often made from layers of different plastic polymers fused together, and often include additional components such as a spout or closure. This compound packaging cannot be recycled due to the different processing requirements of each polymer layer or component.[20] Due to the nature of their use and high degree of contamination, producers reported that they are all treated as single-use disposable items as cleaning and reusing presents too large a barrier for both sanitation and labour.

[18] Australian Packaging Covenant Organisation 2023, *Flexible plastic: production, consumption and recovery 2020-2021 Fact Sheet*, accessed 28/09/2023 from <https://documents.packagingcovenant.org.au/public-documents/Material%20Fact%20Sheets:%20Flexible%20Plastics>

[19] Niaounakis, M 2019, *Recycling of Flexible Plastic Packaging*, Elsevier Publishing, United Kingdom.

[20] Health Care Without Harm 2021, *Measuring and Reducing Plastics in the Healthcare Sector*, accessed from <https://noharm-europe.org/sites/default/files/documents-files/6886/2021-09-23_Measuring-and-reducing-plastics-in-the-healthcare-sector.pdf>

Case Study – Encouraging Vets to Make More Sustainable Choices

Vet Sustain is a UK organisation with a focus on enabling veterinary professionals to become leaders in sustainability.[1] Encouraging a 'no-waste society' is one of the organisation's goals, which they aim to support through equipping veterinary professionals and businesses with the tools to improve sustainability.

The organisation formed a Food and Farming Working Group to conduct projects that appeal to the motivations of both veterinarians and farmers and drive effective change toward sustainable farming practices.[1]

Providing education and training are key action areas that Vet Sustain uses to advance its objectives. The organisation produces a wide range of easily accessible materials, from training courses and webinars, to guides, checklists and posters. One webinar, for example, targeted sustainable use of veterinary consumables through discussions on ethical sources of equipment and correct consumable disposal. The organisation also collates useful external resources and acts as an information centre on best-practice sustainable veterinary care.

Vet Sustain provides an example of a strong and coordinated effort by veterinarians to improve sustainability through education and awareness raising. They have defined targets and actions, working groups and aligned projects. Their example shows that effective leadership can help to coordinate sustainability efforts across an industry. Their education resources could be useful for farm veterinarians in Australia to improve sustainability.

C.2.1 Avoid And Reduce

While avoidance of insemination equipment may not be feasible for the industry, a focus on small reductions in plastic quantities at farm level could have a large cumulative impact on plastic waste to landfill. APCO has identified multi-material laminate soft plastics, such as pouches, as a problematic plastic 'on notice' for further action.[21] APCO recommends that these plastics are eliminated where possible and redesigned to reduce their plastic contents. This advice could be translated to on-farm practice by avoiding single-use pouches in favour of reusable or recyclable alternatives like bottles. It is interesting to note that one producer reported that usage rates of semen pouches and bottles were actually similar, however pouches are immediately disposed of while bottles are reused, contributing to the vast difference in item numbers observed in the waste model. To create effective behaviour change and education initiatives and encourage equipment reuse, it would be useful to understand why producers prefer pouches over bottles in some applications and how the use of bottles could be further adopted.

One small action for producers to limit the amount of plastics in insemination equipment is to choose lighter weight products for purchase and use on farm. While the number of items to landfill may not change, the overall cumulative weight could significantly decrease. If feasible, producers could avoid problematic pouches and opt for bottles made from semi-flexible Low Density Polyethylene (LDPE), provided they are cleaned and reused, or recycled. Over the longer term, manufacturers of plastic

[21] Australian Packaging Covenant Organisation 2023, *Action Plan for Problematic and/or Unnecessary Single Use Plastic Packaging,* accessed 06/09/2023 from <https://documents.packagingcovenant.org.au/public-documents/Action%20Plan%20for%20Problematic%20and%20Unnecessary%20Single-Use%20Plastic%20Packaging>

packaging are encouraged by APCO to redesign packaging to be lightweight, reducing the overall amount of plastics in product construction. Optimally, manufacturers should redesign flexible packaging so that it only uses one type of recyclable plastic to enable processing – an aim set by the Circular Economy for Flexible Plastics initiative (CEFLEX.)[22]

C.2.2 Reuse

Insemination catheters are the third largest source of plastic veterinary waste in the pork industry, after disposable gloves and semen pouches. Early models of catheter were made from durable rubber and are still commercially available despite having fallen out of favour.[23] These were designed to be reused following sterilisation by boiling in distilled water.[24] Reusable catheters have largely been replaced by single-use plastic catheters, which are often cheaper and eliminate the labour and cost involved in sterilisation. They are also perceived to be a safer option, as they reduce the risk of infection that may arise from reuse. One producer reported that they would consider using reusable catheters if there were an easier and faster way to disinfect them, for example, with a disinfectant product bath. One further factor that complicates catheter reuse is that soaps, detergents and disinfectants can have spermicidal properties, and their use with catheters can impact insemination success. These issues present some barriers to choosing reusable catheters. However, education and awareness-raising could help to shift attitudes away from disposable items.

There is also an opportunity to research and develop new, simple and more efficient methods of sterilisation, which may help to convince producers on the value of reusable equipment. Cleaning and sterilisation for reuse – known as 'reprocessing' – of medical and veterinary equipment is common and there are many companies that specialise in offering this service, for example Melag, Whiteley and Sterequip.[25] These companies offer a wide range of equipment reuse solutions that meet human medical standards, for example on-site cleaner-disinfector systems, instrument disinfectant and sterilant chemicals and external reprocessing services. The pork industry could partner with an instrument reprocessing company to design and deliver cleaning and reuse solutions tailored specifically to piggeries.

C.2.3 Recycle

Some insemination equipment may be recyclable provided it is clean and can be transported to recycling centres. Semen bottles, which are often reused, are likely to be made from rigid LDPE due to its translucent and semi-flexible qualities. Rigid LDPE is recyclable through some Council services, unlike LDPE film. Rubber catheters may also be recyclable once they reach the end of their use, depending on council recycling services. There are some significant barriers to be addressed if these items are to see increasing rates of recycling in the industry. Firstly, most producers favour single-use, disposable insemination equipment, therefore increasing use of recyclable options through education and awareness is key. Second, these items must be cleaned on-farm prior to recycling to remove any contamination, so developing simple and efficient sterilisation or cleaning methods may help. Finally,

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[22] A Circular Economy for Flexible Packaging 2023, *Designing for a Circular Economy: Recyclability of polyolefin-based flexible packaging*, accessed 28/09/2023 from <https://guidelines.ceflex.eu>

[23] Business Queensland 2022, *Equipment used in pig artificial insemination,* Queensland State Government, accessed 28/09/2023 from <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/animal/industries/pigs/breed/inseminate/equipment>

[24] Queensland State Government 2022, *Equipment used in pig artificial insemination*, Business Queensland, accessed 07/08/2023 from <https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/animal/industries/pigs/breed/inseminate/equipment>

[25] Clinical Excellence Commission 2023, *Reprocessing of Reusable Medical Devices*, New South Wales State Government, accessed 28/09/2023 from <https://www.cec.health.nsw.gov.au/keep-patients-safe/infection-prevention-and-control/Reprocessing-of-Reusable-Medical-Devices#:~:text=Reprocessing%20is%20a%20multistep%20process,(if%20applicable)%20and%20storage.>

the cost and logistics barrier of transporting items to recycling centres, or providing drop-off points for producers, must be overcome by facilitating easier recycling access.

C.2.4 Summary

Insemination equipment is a challenging area for plastic waste reduction due to the preference for single-use disposable items. Reusable alternatives do exist, however labour costs and convenience are significant barriers to behaviour change. Coordinated efforts are needed to encourage more sustainable product choices on-farm, and also to facilitate reusing or recycling where possible. Producers would need to see the benefits of cleaning and reusing items like insemination catheters and semen bottles over the additional time and labour required, in order to improve their practices. This demonstrates an opportunity for an industry-level education and awareness campaign to target producer behaviours around single-use plastics, and possibly for research into simple and efficient ways of sterilising reusable equipment.

C.3 Personal protective equipment

ACTION	PRACTICES	ASSESSMENT
AVOID AND REDUCE 	▪ Avoid **unnecessary use of gloves** and disposal of unused gloves ▪ Choose **lighter-weight products** to reduce overall plastic to landfill	
REUSE 	▪ Choose **reusable PPE** like earmuffs instead of ear plugs	
RECYCLE 	▪ **Swap disposable plastic** items for genuinely recyclable or compostable alternatives, e.g., certified home-compostable gloves	

Achievable – simple and effective options are available or could easily be developed

Somewhat achievable – barriers may include cost, logistics or behaviour

Challenging – significant cost, logistical or behavioural barriers to change

Personal Protective equipment (PPE) represents the second-largest proportion of plastic veterinary waste produced in the pork industry, totalling over 40% of plastic waste by units, and over 30% by weight. The most common plastic PPE items in use are disposable gloves, earplugs and sleeves. Plastic use modelling suggests that over 2.5 million disposable gloves are used each year, equalling almost 13 tonnes of waste. Considering the magnitude of this waste, PPE would be a productive area to target for plastic reduction actions as there is potential to make significant impact. There is also no direct productivity benefit gained from the reliance on excessive disposable PPE use, adding another reason to target this waste stream.

Engagement with pork farmers revealed that by number of items, gloves are the most used disposable plastic item in the industry. Non-sterile nitrile and nitrate-free gloves are used extensively for protecting the wearer whilst performing veterinary procedures such as assisting with sow farrowing. Some interviewees expressed their concern that disposable gloves were over-used, for example where workers take multiple pairs in case one tears and dispose of all of them at the end of a shift, whether used or not. Interviewees also reported that gloves were primarily used for maintaining hygiene during veterinary activities, rather than for biosecurity reasons. Disposable gloves are typically made from lightweight films comprised of synthetic rubbers, polyvinyl chloride (PVC) or polyethylene. Like other

plastic films, these materials are especially problematic because they become entangled in recycling machinery, contaminate recycling streams, and have a very high litter propensity due to their lightweight and easily fragmentable nature.

Case Study – Gloves In Medical Practice

Disposable gloves and other plastic PPE items are an environmental problem in the human medical industry which has attracted attention and pressure for change. Research in Europe found that in human medical practice, gloves are often used unnecessarily while hand hygiene is neglected, increasing the risk of cross-contamination.[1] Similarly to the pork industry, non-sterile gloves are one of the most purchased products in hospitals.

At the Great Ormond Street Hospital in the United Kingdom, a successful staff education campaign was launched to simultaneously improve hand hygiene while reducing the use of disposable gloves. Campaign leaders tackled the issue by developing a staff awareness program with high visibility in the workplace and updating training procedures. Staff were asked to risk assess whether gloves were needed for each activity, with gloves needed where the likelihood of coming into contact with bodily fluids was highly likely or certain.[1]

The campaign reduced disposable glove use by 4.3 million gloves in its first year – saving 21 tonnes of waste from landfill and the equivalent of almost AUD$200,000 in purchase and disposal costs. Hand hygiene improved, staff reported less glove-related skin conditions, and no increase in infection rates was observed. Importantly, the campaign helped staff make better decisions on when gloves were necessary and when they were avoidable, and prioritised good hand hygiene over the unnecessary use of gloves.

C.3.1 Avoid And Reduce

Engagement with pork farmers suggests that significant reductions of plastic waste to landfill could be achieved by targeting unnecessary use of disposable gloves and changing some practices around PPE use. The example of gloves in the medical industry above suggests that targeting staff education and awareness can be an effective way to approach ingrained behaviours around disposable PPE use, while ensuring appropriate hygiene is maintained. Gloves should be used where workers are highly likely or certain to come into contact with animal fluids, but may be reduced or replaced with hand washing where the risk of contact is low. A campaign to raise awareness on this issue could include other PPE items such as disposable aprons, sleeves and ear plugs, focusing on essential use of PPE and avoidance where it is not needed.

Choosing PPE items such as gloves more carefully, in terms of their plastic contents, can also help to reduce plastic volumes to landfill. As part of their research into PPE use in the human medical industry, Healthcare Without Harm found that choosing lighter weight gloves can reduce total plastic use without compromising on quality or compliance. One hospital that participated in the research found that lighter gloves could save 10 tonnes or 5% of their total annual plastic waste from landfill. Making more selective choices on the types of items available for staff at pork farms could help to reduce overall plastic volume to landfill, while maintaining glove use in activities that strictly require them.

C.3.2 Reuse

Many disposable PPE items that are used in the pork industry could be replaced with reusable items, reducing plastic waste to landfill. For example, disposable ear plugs used in the industry numbered

over 400,000 per year, equalling over 1 tonne of plastic waste. Earplugs are commonly made from PVC foam, which is reported as one of the most environmentally damaging forms of plastic and a key area for avoidance efforts.[26] Disposable ear plugs could quite easily be replaced with reusable earmuffs, which serve the same purpose of hearing protection in the workplace. Replacing this common disposable item with a durable, reusable product could keep up to a tonne of harmful PVC out of landfill every year. Similarly, disposable plastic aprons can be replaced with reusable, durable aprons – a suggestion provided during engagement with one pork farm which had enacted this practice. Reusable gloves should be favoured for activities that do not involve a high risk of contact with animal fluids.

C.3.3 Recycle And Compost

Recyclable alternatives to disposable plastics are available, and these could present a positive environmental step where PPE avoidance or reuse is not feasible. Many disposable glove alternatives exist that claim to be recyclable or biodegradable, however recyclability depends on the services offered in a given local area, and many 'biodegradable' products will only break down in industrial composting facilities equipped with specialised technology, and not in landfill or conventional composting. Due to these facts, care needs to be taken when selecting truly recyclable or compostable alternatives to plastic.

Swapping disposable items for genuinely compostable bioplastics where appropriate could also help the pork industry to reduce plastic to landfill. Compostable Alternatives South Australia produces a non-sterile resistant glove made from cornstarch and biodegradable polymers that has achieved home composting certification in Australia, meaning that it will biodegrade in temperatures around 30-35°C. The company claims that the gloves will degrade in up to four months, whether in landfill or a home compost system, and do not produce any toxic residues as the majority of components are naturally derived.[27] One component in their gloves, polybutyrate adipate terephthalate, is petrochemically derived. They offer bulk orders and have partnered with multiple companies to reduce plastic waste to landfill. Swapping disposable plastic gloves for a bioplastic alternative which does not produce toxic residues during decomposition and decomposes at low temperatures could present an option for reducing plastic waste to landfill even where disposable gloves continue to be used for hygiene reasons.

As a last resort, the pork industry could reduce plastics to landfill by partnering with companies that provide recycling or composting solutions to address disposable plastic PPE use. Some examples of partnerships like this exist, for example Terracycle's partnerships with pharmaceutical brands to recycle product packaging, or Kimberly-Clark's RightCycle Program for PPE.[28,29] PPE falls into the category of hard-to-recycle waste, generally due to its lightweight plastic composition and high levels of contamination. Terracycle claims to be capable of processing hard-to-recycle waste and will accept a range of disposable PPE and some veterinary waste. However, there is some lack of transparency on how and where the actual recycling takes place.[30] Prior to engaging in a partnership with any

[26] Health Care Without Harm 2021, *The polyvinyl chloride debate: Why PVC remains a problematic material*, accessed 04/09/2023 from <https://noharm-europe.org/sites/default/files/documents-files/6807/2021-06-23-PVC-briefing-FINAL.pdf>

[27] Compostable Alternatives SA 2023, *Disposable gloves*, accessed 04/09/2023 from <https://www.compostablealternatives.com.au/product/disposable-gloves/>

[28] Terracycle 2023, *Discover our recycling process*, accessed 04/09/2023 from <https://www.terracycle.com/en-AU/about-terracycle/our_recycling_process>

[29] Kimberly-Clark 2023, *RightCycle by Kimberly-Clark Professional,* accessed 25/09/2023 from <https://www.kcprofessional.com/en-us/solutions/rightcycle-by-kimberly-clark-professional>

[30] Kaufman, L 2022, *The Warehouses of Plastic Behind TerraCycle's Recycling Dream*, Bloomberg, accessed 25/09/2023 from <https://www.bloomberg.com/features/2022-terracycle-tom-szaky/>

recycler, the pork industry and its producers ought to gain clarity on plastic processing and end-products to ensure the partnership has genuine environmental benefits.

C.3.4 Summary

Disposable PPE is one of the most common sources of plastic waste across both the pork and medical industries. While it is difficult to avoid disposable PPE altogether, research in the human medical industry has found that the use of non-sterile gloves is often unnecessary and could be replaced with improved hand hygiene, saving waste and money in the process. Targeted education and awareness campaigns are needed to help staff to avoid unnecessary use of items such as gloves. Following avoidance of unnecessary plastic use, replacing disposable items with reusable alternatives where safe and practical is another approach that could see the pork industry reduce plastic waste to landfill. Simple changes such as replacing disposable ear plugs with more durable earmuffs could keep tonnes of harmful plastics out of landfill. As a third course of action, utilising recycling schemes or investigating compostable bioplastic alternatives where disposable items cannot be avoided can help to ensure the same hygiene and compliance standards are maintained, while reducing the overall amount of plastics in landfill.

C.4 Medication and Vaccination

ACTION	PRACTICES	ASSESSMENT
AVOID AND REDUCE 	▪ **Implement needle-free** technology to eliminate syringes and needles ▪ Choose **lighter-weight products** to reduce overall plastic to landfill	
REUSE 	▪ Choose **reusable syringes and dosing guns** ▪ **Educate** on reuse protocols	
RECYCLE 	▪ **Clean and recycle** medication bottles and containers ▪ **Facilitate recycling collection** where needed	

Achievable – simple and effective options are available or could easily be developed

Somewhat achievable – barriers may include cost, logistics or behaviour

Challenging – significant cost, logistical or behavioural barriers to change

Medication equipment and packaging represent over 20% of the plastic veterinary waste produced in the pork industry and total approximately 13 tonnes per year, based on the results of modelling. Just over half of this amount is made up of the packaging of medicines and vaccines – plastic bottles and caps – with the remainder comprising medication delivery equipment – dosing guns, tubes and syringes. Over 200,000 plastic syringes are used and disposed of each year across the industry, along with approximately 200,000 medication bottles and their caps.

Medications and vaccines are an essential component of animal production, and producers are reliant to some extent on the manufacturers of these products for the type and quantity of packaging material. Most larger medication containers are made from recyclable HDPE plastic, however the cost of transporting containers to recycling centres is a barrier for many farms, and containers are often incinerated on-site or sent to landfill. Engagement with pig producers revealed their strong desire to deal with medication packaging in a more sustainable manner. One farm reported that medications often come with additional plastic tubes that are not needed in the same ratio as the bottles, as tubes

can be reused. This highlights that collaboration between the pork industry and manufacturers to reduce plastic waste could provide mutual benefits. Improved systems for collecting and managing packaging waste are needed to assist producers to recycle as much of their plastic packaging as possible.

Medication delivery equipment – dosing guns, syringes and needles for example – are an area that producers generally have more direct control over than packaging. This area could be targeted for practice change to achieve reductions in waste to landfill, if the barriers of cost and convenience can be overcome. Several farms reported reusing dosing guns, syringes and needles where safe and convenient. Extending the use of reusable medication delivery systems could lead to significant reductions in plastic waste to landfill.

Case Study – Needle-Free Vaccines In The Pork Industry

Needle-free technology is used by many pork producers for vaccinating piglets, and its use could be expanded to do away with the traditional needle and syringe approach, potentially eliminating hundreds of thousands of plastic syringes from landfill each year. Needle-free vaccine technology works by placing a liquid vaccine under pressure, and expelling it in a narrow jet that is capable of travelling through the animal's skin and into the tissue in a fraction of a second.[1] The technology is intended for long-term repeated use, and devices are made from durable stainless steel and plastic.

Needle-free vaccine technology is commercially available for pig farmers and has a range of benefits. Firstly, needle-free vaccines are sterile as the reuse of needles between animals is eliminated, reducing the risk of cross-contamination.[1] It also eliminates the risk of broken needles, abscesses and carcass defects which can occur with needles – benefitting both animal welfare and product value.[1] Eliminating needles prevents accidental needle-stick injuries to workers. The technology also reduces fear and pain reactions in animals, leading to a calmer environment for both animals and workers. Needle-free vaccines generally use less vaccine volume delivered in a more precise and consistent manner, saving on long-term costs of vaccines and delivery equipment, as well as plastic waste. Research has shown that the immune response triggered through needle-free vaccines can be superior to conventional syringes.[1]

The biggest barrier to implementing needle-free technology is the initial cost of the equipment. Some farms have found the benefits to justify the cost and have implemented the technology for piglets on sow farms, where large numbers of injections can be delivered with a small number of devices. Some needle-free device models can be used on both piglets and sows, or allow the hand piece to be changed depending on animal size, extending the use of the device. When calculating the cost-benefit of implementing or expanding this technology, producers can consider costs saved through avoidance of syringes and needles, as well as indirect costs like disease transmission, labour inefficiencies, worker injuries, and decreases to yield due to tissue damage. Some needle-free suppliers offer a lease or subscription program for producers, giving more flexibility to trial the system and save on initial costs.

C.4.1 Avoid And Reduce

Avoiding plastics in medication and vaccination may be a difficult task for most pork producers, however there are feasible practice changes that could create a significant positive impact over time. These practice changes can be small, for example by ordering equipment more selectively, or they can

be large, for example by implementing needle-free vaccination across piglets and sows and significantly reducing reliance on the use of needles and syringes.

One challenge faced in avoiding plastic use in this area is the lack of packaging choices and alternatives major product manufacturers provide to producers. Ultimately, the responsibility of avoiding unnecessary packaging or additional plastics like unneeded tubes, and for packaging recyclability, lies with the manufacturer of the medication. However, this challenge also presents a potential opportunity for APL to collaborate with animal medicine manufacturers to reduce waste in packaging through partnering in product stewardship schemes. Product stewardship encourages manufacturers to share responsibility for the impact of their products, for example through redesign for improved material recovery, repair or recyclability.[31] Product stewardship improves the environmental credentials of a manufacturer, and many example schemes exist in the agricultural industry, for example Agsafe's DrumMUSTER and BagMUSTER stewardship programs.[32]

Possibly the most effective way to avoid plastics to landfill in medication equipment use would be to implement needle-free vaccine systems, which could reduce or eliminate the need for plastic syringes as well as needles. This could be expanded upon with the use of in-feed medications wherever possible. Smaller changes are also possible to reduce total plastic to landfill. In an example from the human healthcare sector, a Swedish health provider worked with their supplier of syringes to switch to a lighter syringe with less plastic, reducing their annual waste by 4.5 tonnes. Effectively avoiding and reducing plastic waste from medication and vaccination will require dialogue between pork producers and the suppliers or manufacturers of the medical products. Collaborating in this way could achieve greater and more enduring reductions in plastic, as waste could be targeted at the manufacturing, supply and use stages.

Figure B-1: Pulse Needle Free Systems' 'Pulse 50 Microdose' – a needle-free dosing gun for delivering small medication volumes. Pulse manufacture needle-free systems for piglets, small pigs and large pigs.[33]

C.4.2 Reuse

[31] Product Stewardship Centre of Excellence 2021, *Product Stewardship Centre of Excellence,* Department of Agriculture, Water and the Environment, Australian Government, accessed 28/09/2023 from <https://www.dcceew.gov.au/sites/default/files/documents/ps-coe-fs.pdf>

[32] Agsafe 2023, *About Agsafe*, accessed 13/09/2023 from <https://www.agsafe.org.au/about-us/about-agsafe>

[33] Pulse Needle Free Technology 2023, *Pulse 50 Microdose,* accessed 28/09/2023 from <https://pulse-nfs.com/pulse-products/>

Reducing plastics to landfill produced in medication and vaccination involves replacing disposable items with systems or products that are designed to be reused many times. This is especially relevant for medication equipment such as dosing guns and syringes, which are already often reused. Encouraging pork producers to choose durable reusable products over those that only last a few uses would reduce the overall amount of plastic disposed of in landfill or incinerated on-farm. For example, stainless steel, glass, and some plastic syringes are designed to be reused, and can be sterilised between uses by boiling in water. Producer awareness of safety and efficacy of reusing these items could be an area to target in order to reduce plastic to landfill. For example, producing factsheets that outline the safe procedures for sterilising and reusing medication equipment, along with recommended reuse limits and risks, could be one way to encourage producers to reuse equipment to the extent that is both safe and feasible.

C.4.3 Recycle

Many of the medication and vaccination items in use across the pork industry are recyclable but are not routinely recycled due to transport and cost barriers. Recycling rates of these common items could increase if systems were established to assist producers in item collection. Most medication bottles and containers are made from HDPE plastic which is commonly recycled in urban and regional areas. However, as some producers do not have access to council recycling services, these items are usually incinerated or disposed of in landfill. Engagement with producers indicated a strong desire to engage in recycling schemes if they are readily available and affordable, and producers themselves had a number of ideas of how this could be achieved.

Several pork producers indicated that they would use recycling services if collection of containers and bottles was facilitated in some way. This could occur through product stewardship schemes between manufacturers and industry. For example, one farmer suggested coordinating medication container collection through veterinarians that may visit several farming operations. They proposed an idea to return used medication containers to their veterinarian, who could assist in directing containers to be recycled. Another farmer indicated their interest in using the DrumMUSTER product stewardship scheme, however they noted that DrumMUSTER will accept some medical containers for recycling but not others, and that it was difficult to separate their containers for separate management. Other farmers were not aware of DrumMUSTER or any recycling schemes, indicating an area to target for education or awareness raising. Separating waste on-farm into different categories could help to facilitate recycling, however education and awareness need to be targeted to ensure this is done effectively.

C.4.4 Summary

Disposable plastics are widely used in medication and vaccine delivery due to their low cost, convenience and to maintain hygiene and safety. Many hundreds of thousands of single use plastic bottles, syringes and tubes are disposed of in landfill or incinerated each year across the industry. Reducing this amount of plastic waste is possible through both small and large practice changes at farm level, for example through more selective purchase and use of disposable items, or farm-wide implementation of needle-free vaccination technology. There are also opportunities for APL to collaborate with product manufacturers, suppliers and recycling companies. Reducing unnecessary plastics at the manufacturing stage will transfer multiple benefits to the environment, and also pork producers through savings in time and costs required for waste disposal. Pork producers expressed their willingness and desire to engage with recycling schemes. Barriers of cost and transport logistics currently exist to recycling plastic medical waste, however these could be addressed through coordinating or facilitating a container and bottle collection scheme or product stewardship scheme.

C.5 Secondary packaging

ACTION	PRACTICES	ASSESSMENT
AVOID AND REDUCE 	▪ **Buy items like catheters in bulk** with less packaging ▪ **Avoid individually wrapped** items ▪ **Contact suppliers** and refuse EPS packing peanuts	
REUSE 	▪ Use **reusable coolers** where biosecurity risks are low ▪ Purchase **reusable ice packs** instead of single-use plastics	
RECYCLE 	▪ **Swap polystyrene boxes** for recyclable and compostable alternatives ▪ Use recycling schemes like Terracycle for packaging	

Achievable – simple and effective options are available or could easily be developed

Somewhat achievable – barriers may include cost, logistics or behaviour

Challenging – significant cost, logistical or behavioural barriers to change

Secondary packaging, comprised of polystyrene boxes, ice packs and product packaging wraps, makes up approximately 7% of plastic veterinary waste produced in the pork industry. This waste stream contributes over half a million items per year, or 3.5 tonnes, to landfill or incineration. These items are usually used in transport, for example polystyrene boxes with ice packs are used to maintain cold temperatures of medications during transport. Product packaging wraps are the plastic films that enclose items such as insemination catheters prior to use. As these items are involved in maintaining safe product temperatures and cleanliness, they may be difficult to avoid altogether but some could be replaced with reusable or recyclable options.

Expanded polystyrene (EPS) packaging is widely used for its lightweight and insulative properties, however it is prone to disintegrating and is easily carried by wind and water, making it an environmental problem. Four out of the nine problematic single use plastics for immediate action identified by APCO are forms of polystyrene. Some pork producers reported that the EPS boxes used to transport medications and semen were reused as much as possible on-farm or by veterinarians, however other farms reported that these boxes were problematic and were either sent to landfill or burnt on site. Burning polystyrene is highly polluting, as it releases noxious emissions that can harm the central nervous system as it burns[34]. In addition to boxes, pork farmers reported that polystyrene loose fill 'packing peanuts' are often used with medication delivery.[35] EPS boxes are recyclable if clean, however the recycling network is fragmented and not easily accessible in regional areas, and there is no recycling market for EPS loose fill packaging.

Secondary packaging wraps are another problematic plastic as there is currently no widespread and easily accessible recycling market for these. Soft plastic packaging is typically made from low density polyethylene (LDPE) or polypropylene. Pork producers reported that items such as insemination catheters commonly come in soft plastic packaging – some products are single-wrapped and others come in multi-packs. As soft plastics do not have an accessible recycling system they are all disposed of in landfill or incinerated.

[34] Verma, R, Vinoda, K. S., Papireddy, M, Gowda, A. N. S. 2016, *Toxic Pollutants from Plastic Waste – A Review*, Procedia Environmental Sciences Vol. 35, accessed 06/09/2023 from <https://www.sciencedirect.com/science/article/pii/S187802961630158X>

[35] Note that EPS packing peanuts were not quantified in the model as limited information was available about the quantity and extent of use on piggeries.

Case Study – Replacing Polystyrene With Waste Wool

ART Lab Solutions export temperature-sensitive cattle IVF media across Australia and around the world, and required a packaging solution that could meet strict quality standards while delivering on environmental sustainability.[1] Previously, they used a plastic box along with 17 kg of ice to maintain temperatures of 2-8°C for 72 hours, which the company identified was both costly to their financial growth and their environmental ethos.

ART Lab Solutions reached out to collaborate with Planet Protector Packaging for an alternative packaging solution that could achieve the same temperature control at lower cost and with improved environmental outcomes.

Planet Protector Packaging produces a temperature-controlled packaging solution made from waste wool and cardboard that outperforms polystyrene in temperature tests.[1] The box can be reused more than polystyrene, and all the components are recyclable or fully compostable and biodegradable.

Planet Protector Packaging provided ART Lab Solutions with a customised box with a thicker lining and 5 kg of frozen gel ice which successfully maintained an internal temperature of 2-8°C for 78 hours in Australian summer conditions and 110 hours in winter conditions. In addition, the box was one-fifth of the price of the former plastic packaging. This translated to a 71% reduction in ice packs required and an 80% reduction in packaging costs.

Planet Protector Packaging works with food and beverage, pharmaceutical and seafood companies to tailor their packaging solutions to each client's needs.

Figure B-1: Planet Protector Packaging 'Pharma Protector', an alternative to EPS packaging.[36]

C.5.1 Avoid And Reduce

For secondary packaging waste, avoidance and reduction centre on making more selective decisions on-farm about what items that are purchased and used. There is also an opportunity for dialogue between the pork industry and suppliers of veterinary items to reduce unnecessary packaging which creates a burden of disposal for pork farmers. At an individual farm level, there are actions that could help to avoid and reduce plastic to landfill or incineration. For example, avoiding catheters that are individually plastic-wrapped in favour of bulk orders with less packaging. Producers could also contact their medication suppliers and request that problematic EPS packing peanuts are removed from their deliveries. APCO recommends that immediate steps be taken to avoid the import, production and sale of EPS packing peanuts, and that customers should advise suppliers that they do not accept this material and request alternatives to protect their products. A coordinated awareness and education campaign for producers in the industry could include a focus on making discerning choices about product packaging, along with a range of other targets for different plastic material types.

C.5.2 Reuse

Polystyrene boxes could potentially be replaced with reusable alternatives, providing biosecurity issues are addressed. Several producers reported that they reused durable plastic 'esky' coolers to store and transport temperature-sensitive materials like medications around individual farms. However, these

[36] Planet Protector Packaging 2023, *Pharma Protector*, accessed 28/09/2023 from <https://planetprotectorpackaging.com/pharma-protector/>

coolers could not be transported between farms due to biosecurity risks posed by dirt, manure and other contaminants that may have come in contact with the cooler. These issues highlight a possible area for practice change at farm level. Reusable coolers could be used wherever safe and feasible on individual farms, ensuring they are appropriately washed, dried and disinfected as required. There are established guidelines and processes for cleaning of vehicle tyres and boots for biosecurity reasons, and equivalent guidelines could potentially be set up for equipment like coolers that are reused around individual farms. Where temperature-controlled packaging is needed for transporting goods between farms, polystyrene boxes can be replaced with recyclable or compostable packaging. To achieve this, farms could be encouraged to perform a waste audit – recording types of waste produced, quantities and sources – to identify where coolers and other items can be reused or replaced.

Ice packs are another common disposable item that could be replaced with reusable alternatives. Producers reported that ice packs are often included in polystyrene boxes of cooled goods such as medications. They are sometimes reused on farm, and some producers may purchase them separately. One producer reported that they had transitioned from disposable plastic ice packs to reusable, durable canvas ice packs because they had a superior cooling capacity and produced less waste. This source of plastic waste could be approached differently depending on the source of the ice packs – whether included in delivered goods from veterinarians or purchased separately by farms. Suppliers of the delivered ice packs could be contacted and notified of the preference for reusable or non-plastic alternatives. Ice packs purchased separately by farms could form an item or action for behaviour change on waste reduction education materials.

C.5.3 Recycle

Where disposable items and packaging cannot be avoided for biosecurity or animal health reasons, recyclable alternatives or recycling scheme partnerships could be sought to deal with the waste produced. There are several commercially-available alternatives to polystyrene boxes on the market that have equal or superior temperature performance and are fully recyclable. Woolpak is a fully recyclable, waste wool and cardboard alternative based in Australia which can customise their boxes to client's needs. Recycled and recyclable paper-based alternatives include TempGuard and Chilltainer boxes. These alternatives are all either garden compostable or recyclable via local council services.

Despite the difficulties with recycling soft plastic packaging, especially in regional and rural areas, there are some possibilities for establishing partnerships between producers and recyclers to prevent plastics ending up in landfill or incineration. The main barrier to recycling soft plastic packaging is the current lack of a viable market for the recycled end-product, which is generally low in value and quality. Some recycling companies still process these materials at a cost. Terracycle offers recycling for soft plastics and plastic packaging transported via post, however at a reasonably high cost.

While soft plastics recycling is not currently operating at scale in Australia, localised partnerships provide examples for further cooperation. Busselton Veterinary Hospital in Western Australia partnered with SUEZ waste management group to recycle a large proportion of their disposal veterinary plastics. At industry scale, trials for recycling soft plastic silage wrap through Dairy Australia, and trials for horticultural and grain production plastics in regional Victoria, have all been completed. These examples demonstrate that opportunities for recycling partnerships can be found and can help lead the way as larger-scale solutions for packaging recycling are forged across the country.

C.5.4 Summary

Secondary packaging plastics are widely used for wrapping products and equipment to protect, maintain hygiene and provide the right conditions for delivery. However, these are plastic products that are mostly redundant by the time they get to the farm. Reusing these items internally, for example reusing EPS boxes or ice packs is likely the most efficient to maintain the items in circulation for longer.

Case Study – Vet Plastics Recycling Partnership

Busselton Veterinary Hospital in Western Australia found forming partnerships for recycling their plastic waste was one key part of reducing the practice's waste to landfill by 80%.[1]

The Vet Hospital partnered with SUEZ waste management group to coordinate the recycling of items that can't typically be recycled through local council schemes. Items such as PVC bags and tubes, small hard plastics, disposable gloves, blister packs and medicine packaging are now sent for recycling, where typically these items are disposed of in landfill. The practice set up an on-site collection hub where staff separate these items into designated bins, and recycling is managed by SUEZ.

This partnership has helped the practice achieve a higher degree of sustainability while acknowledging that some single-use plastics cannot be eliminated completely due to animal care needs and veterinary protocols.

Appendix D: Education materials to reduce veterinary plastic waste

Table D-1: Example education materials for reducing waste in the pork industry

EDUCATION MATERIAL	TARGET AUDIENCE	POTENTIAL TOPICS AND TARGETS	EXAMPLE
Webinars and masterclasses	Piggery owners and managers	▪ Waste audits ▪ Creating a culture of waste reduction in piggeries ▪ Fostering partnerships for waste reduction ▪ System and behaviour change for waste reduction ▪ The costs and benefits of reducing waste	Vets for Climate Action webinars, e.g., "Creating a Team Culture of Sustainability", "Sustainability in the Beef Supply Chain"[37].
Sustainability guides	Piggery owners and managers	▪ Case studies in farm waste reduction ▪ A guide to the waste hierarchy for piggery owners and managers ▪ A guide for recycling plastic waste ▪ A guide for safely cleaning and reusing selected veterinary items ▪ A guide for implementing waste reduction systems on-farm ▪ A guide to more sustainable choices in veterinary items	Vet Sustain guides, e.g., "An Introduction to Sustainability in Farm Vet Practice"[38].
Training courses	Piggery owners, managers and staff	▪ For owners and managers: ▪ Steps to reducing plastic waste, looking into different material types and options ▪ Encouraging sustainable practices and behaviours in staff ▪ For staff: ▪ Training in appropriate PPE use ▪ Training in safely cleaning and reusing selected veterinary items ▪ Training in correct recycling ▪ Integrating waste reduction into existing training for new staff	Vet Sustain training course "A Veterinary Approach to Sustainable Food and Farming", Vets for Climate Action Climate Care Program[39,40].

[37] Vets for Climate Action 2023, *Videos and Webinars,* accessed 25/09/2023 from <https://www.vfca.org.au/videos_and_webinars>

[38] Vet Sustain 2021, *An Introduction to Sustainability in Farm Vet Practice*, accessed 25/09/2023 from <https://vetsustain.org/resources/into-to-sustainability-farm-practice>

[39] Vet Sustain and Vet Salus 2023, *A Veterinary Approach to Sustainable Food and Farming,* accessed 25/09/2023 from https://learn.vetsustain.org/courses/veterinary-approach-to-sustainable-food-and-farming-free-preview

[40] Vets for Climate Action 2023, *About the Climate Care Program,* accessed 25/09/2023 from <https://www.vfca.org.au/about_climate_care>

EDUCATION MATERIAL	TARGET AUDIENCE	POTENTIAL TOPICS AND TARGETS	EXAMPLE
Standardised protocols	Piggery owners, managers and staff	▪ Recycling protocols ▪ Safe cleaning and reuse of selected veterinary items ▪ Protocols for correct PPE use	Australian Veterinary Association "Guidelines for Veterinary Personal Biosecurity" and resources for PPE, hand hygiene, biosecurity etc[41,42].
Posters, factsheets and checklists	Piggery owners, managers and staff	▪ Waste reduction checklists ▪ Recycling factsheets ▪ Poster guides for PPE use ▪ Poster guides for cleaning and reusing veterinary items	Vet Sustain checklists and posters, e.g., "Greener Veterinary Practice Checklist"[43].

[41] Australian Veterinary Association 2017, *Guidelines for Veterinary Personal Biosecurity: third edition*, accessed 25/09/2023 from <https://www.ava.com.au/library-journals-and-resources/ava-other-resources/veterinary-personal-biosecurity/>

[42] Australian Veterinary Association 2023, *Veterinary Personal Biosecurity and PPE,* accessed 25/09/2023 from <https://www.ava.com.au/library-journals-and-resources/ava-other-resources/veterinary-personal-biosecurity/>

[43] Vet Sustain 2021, *Greener Veterinary Practice Checklist,* accessed 25/09/2023 from <https://vetsustain.org/resources/vet-practice-checklist>