DESIGNING
A MANAGEMENT PROGRAM FOR EMPTY PLASTIC PESTICIDE CONTAINERS IN KARAWANG REGENCY

Field interviews with the local parties; retailers, kiosks, farmers, collectors, and waste management companies.

Passachol Srethasirote
Pichayathida Treethammarak
Tanaporn Sibpadsenthong
Tarinee Sae-lee

bsacpesticide@gmail.com

Designing a Management Program for Empty Plastic Pesticide Containers in Karawang Regency, Indonesia

An Interactive Science and Social Project (ISSP)
Submitted to the Department of Chemistry, Faculty of Science
CHULALONGKORN UNIVERSITY

In partial fulfillment for
Bachelor of Science in Applied Chemistry Program

By
Passachol Srethasirote, Pichayathida Treethammarak,
Tanaporn Sibpadsenthong, Tarinee Sae-lee

February 27, 2019

To
Project Advisors:
Prof. Supawan Tantayanon, Chulalongkorn University
Prof. Numpon Insin, Chulalongkorn University

Sponsor:
CropLife Indonesia

This report represents the work of four Chulalongkorn University students submitted to the Faculty of Science part of the degree requirements.

Abstract

Karawang Regency is a large area used for agriculture which has a high volume of pesticide usage and harmful disposal of the pesticide containers. Most of the farmers do not know the proper way to handle the empty containers. In addition, inappropriate disposal methods have resulted in counterfeit products, an immense side effect of pesticide usage. CropLife Indonesia wants to address this problem by setting a baseline study of the current situation in order to implement a containers management program in Karawang Regency. We interviewed the relevant stakeholders, analyzed the data, suggested possible waste management methods, and designed a management program to address the problem. We recommended an empty plastic pesticide containers management program be implemented by pesticide manufacturing companies as well as the government.

Acknowledgments

We would like to thank the following people and organizations for their support and guidance throughout our project:

- Our sponsor, CropLife Indonesia, for allowing us to work with them in the empty pesticide containers management baseline study in Karawang Regency. *CropLife Indonesia team: Mr. Agung Kurniawan, Mr. Adji Wibowo, Ms. Arunika Anggradewi, Ms. Sylvia Witlin, Mr. Vicki Rizki Arneldi, Mr. Muhammad Faishal, Mr. Askif Pasaribu, Mr. Budi Noviyanty, Mr. Amien Teibang, Ms. Ira Rachmawati.*
- Ms. Mayang-Sari Marchainy, a legal team from CropLife Indonesia, for giving us information on the legal regulations of Ministries in Indonesia.
- Ms. Arum Tri Pusposari from PPLi Company, for dedicating her valuable time to provide with information about the recycling process.
- Mr. Yanyan Fauzi from Holcim-Geocycle Company, for dedicating his valuable time to provide us with information about the co-processing process.
- Our advisor, Prof. Supawan Tantayanon, Prof. Numpon Insin, Prof. Siripastr Jayanta from Chulalongkorn University, Prof. Gary Pollice, and Prof. Brajendra Mishra from Worcester Polytechnic Institute, for their guidance, insight, and support throughout our project.
- Ms. Chiraporn Wacharasindhu and Ms. Julia Virulchanya for dedicating their valuable time to give feedback and comments on the English writing.
- The students from the State University of Jakarta for helping us interview the local retailers/kiosks, farmers, and pesticide containers collectors in Karawang Regency.
  Students from State University of Jakarta: Miss Noviana Misnannisah, Miss Tinne Okta Triani Putri, Miss Atikah Aulia Putri, Miss Rosita Ayu Meidyana, Miss Wulanda Sari, Mr. Susatio Hudan Abdurrohman, Mr. Yoga Alden Rezaldi, Mr. Hidayat Ullah, Miss Yuly Ulan Dari, Mr. Ilham Fauzan Hari Murti, Miss Ingriani Indah Amini.

Executive Summary

Pesticides are chemical substances used to control pests. Because of their benefits, the rate of pesticide usage has been increasing every year and wherever pesticides are used, empty pesticide containers are generated. Without proper management of empty pesticide waste containers, the residue in the containers can contaminate the environment and pose a threat on all living organisms. This project was developed in Indonesia where the main focus was on Karawang Regency. Karawang has been found to be one of the areas where a lot of farmers are heavily using pesticides. Moreover, it is also one of the major areas that experience counterfeit products due to the absence of an empty pesticide containers management program. Several researches for background information were performed, including the legal regulations of Indonesia, case studies of successful management programs across the world, and the possible waste management methods, in order for our team to come up with a management program that will be most suitable for Karawang.

Project Goal

In the absence of a management program, the pesticide containers not only have a negative impact on the communities and environment but they also affect the reputation of companies whose containers are refilled with a counterfeit solution and resold to farmers. Hence, the goal of this project is to design a management program for empty plastic pesticide containers in Karawang Regency.

In order to create such a program, our project sought to accomplish the following objectives:

Objective 1: To understand the behavior of the local Indonesian retailers/kiosks, farmers, and containers collectors.

Objective 2: To analyze possible empty plastic pesticide containers recovery and disposal methods based on a set of criteria.

Objective 3: To design a management program for empty plastic pesticide containers in Karawang Regency

Methodology

For Objective 1, our team developed a set of interview questions in English and then translated them into Bahasa (see Appendix E), the official Indonesian language, with help from seven students from the State University of Jakarta for the benefit all of the interviewees who spoke in Bahasa. Interviewees were individually interviewed with open-ended questions. All the interviews were conducted in Bahasa,

and the answers were later translated into English. We performed the interviews in three villages of Karawang; Cilamaya, Wadas, and Jatisari. We interviewed three retailers and two kiosks, eleven key farmers, and nine collectors.

The second objective was to analyze four waste management methods - reuse, recycle, co-processing, and landfill, based on four criteria that we came up with which were: capability, regulations, counterfeit prevention, and impact.

The third objective was to integrate the data from the first and second objectives to design a management program for empty plastic pesticide containers in Karawang Regency.

Results/Key Findings

Completion of the previously stated objectives resulted in a collection of raw data, which we then analyzed and came up with key findings. These findings provided useful information for designing a management program.

From the field interviews, we found that the counterfeit product identification was not a problem in Karawang. All of the retailers, kiosks, and farmers were able to distinguish between the authentic and counterfeit ones. However, none of the retailers and kiosks told the farmers how to deal with empty pesticide containers. Moreover, even though most of the key farmers performed the “Triple-rinse” followed by puncturing the pesticide containers, we were unable to determine the behavior of the sub-farmers. Lastly, based on the interviews, we were able to come up with a flow of pesticide containers in Karawang for which the final step was unknown since we did not know the people who traded with the collectors. In addition, there was also loss of a large number of pesticide containers in the flow, because only 3% of the number of empty containers disposed by farmers were collected by the collectors.

From the analysis of possible waste management methods, we found that based on four criteria, recycling and co-processing were the two methods that were suitable for Karawang Regency. Furthermore, from the flow of pesticide containers in Objective 1, we could identify the problematic part that caused the empty pesticide containers to go out off-track; this was due to the middlemen and collectors. Therefore, we removed them from the value chain and decided to make the retailers responsible for the collection of the empty pesticide containers instead. Lastly, we put the retailers in contact with the waste management companies through the transporters and used a barcode system to track the containers from the time of leaving the manufacturers until reaching the recycling or co-processing companies.

Conclusion

From the data analysis, even though we were able to identify the problematic part, select the most suitable waste management methods, and design the management

program, this program still cannot be successful in current Karawang's situation due to some of the habits of local retailers/kiosks, farmers, and collectors as well as the legal regulations. Thus, we have made recommendations on how the management program that we designed can be implemented successful.

Recommendations

There are four major actions that should be undertaken concurrently for the management program to work:

- Government involvement is necessary to monitor the program and approve triple-rinse method.
- An education program should be arranged for retailers, kiosks, and farmers in order for them to understand the effects of counterfeit products and learn about good practice for handling empty pesticide containers.
- A tracking system for pesticide containers should be put into practice to make sure that there will be no missing containers during each step of the management program.
- Incentives should be created to motivate the participation of relevant stakeholders in the management program.

บทสรุปผู้บริหาร

สารกำจัดศัตรูพืช คือ สารเคมีที่ใช้เพื่อป้องกัน ควบคุม และทำลายศัตรูพืช เนื่องด้วยคุณประโยชน์เหล่านั้น อัตราการใช้สารกำจัดศัตรูพืชจึงเพิ่มขึ้นในทุก ๆ ปี ส่งผลให้ซากบรรจุภัณฑ์เคมีเกษตรเพิ่มขึ้น หากปราศจากวิธีจัดการกำจัดซากบรรจุภัณฑ์เคมีเกษตรอย่างถูกต้องและเหมาะสม สารตกค้างในซากบรรจุภัณฑ์เหล่านั้นอาจส่งผลกระทบต่อสิ่งมีชีวิตและสิ่งแวดล้อมได้

โครงการนี้ถูกจัดทำขึ้นเพื่อเป็นแนวทางในการศึกษาขั้นพื้นฐานของวิธีจัดการในการกำจัดซากบรรจุภัณฑ์เคมีเกษตรอย่างเหมาะสมในประเทศอินโดนีเซีย โดยใช้เขตคาราวางเป็นพื้นที่ตัวอย่าง ด้วยเหตุผลหลักสองประการ คือ หนึ่ง พื้นที่นี้เป็นหนึ่งในพื้นที่ที่มีการทำเกษตรกรรมอย่างกว้างขวาง และมีการใช้สารกำจัดศัตรูพืชอย่างแพร่หลาย สอง คาราวางเป็นเขตที่มีการพบการแพร่ระบาดของผลิตภัณฑ์สารกำจัดศัตรูพืชลอกเลียนแบบ อันเนื่องจากไม่มีมาตรการควบคุมซากบรรจุภัณฑ์เคมีเกษตรอย่างเหมาะสม ดังนั้น คณะผู้วิจัยจึงทำการศึกษาค้นคว้าข้อมูลที่เกี่ยวข้อง อาทิ กฎหมายและมาตรการของประเทศอินโดนีเซีย กรณีศึกษาจากต่างประเทศที่ประสบความสำเร็จด้านการจัดการซากบรรจุภัณฑ์เคมีเกษตร และวิธีการกำจัดซากบรรจุภัณฑ์เคมีเกษตรที่มีความเป็นไปได้ในประเทศอินโดนีเซีย เพื่อออกแบบโปรแกรมการจัดการซากบรรจุภัณฑ์เคมีที่เหมาะสมกับเขตคาราวาง

เป้าหมายของโครงการ

การขาดมาตรการจัดการซากบรรจุภัณฑ์เคมีเกษตรไม่เพียงแต่ก่อให้เกิดผลกระทบต่อสังคมและสิ่งแวดล้อม แต่ยังมีผลกระทบต่อชื่อเสียงของบริษัทเคมีภัณฑ์อีกด้วย เนื่องจากมีการเก็บบรรจุภัณฑ์เปล่าที่ถูกใช้แล้วไปปลอมแปลงด้วยการเติมสารเคมีชนิดอื่น แล้วนำไปขายให้กับเกษตรกร ด้วยเหตุนี้ โครงการนี้จึงมีเป้าหมายในการออกแบบระบบการจัดการกำจัดซากบรรจุภัณฑ์เคมีจากพลาสติกที่เหมาะสมกับเขตคาราวาง

ในการออกแบบระบบนั้น โครงการศึกษาพยายามที่จะบรรลุวัตถุประสงค์ดังต่อไปนี้

วัตถุประสงค์ที่ ๑ เข้าใจพฤติกรรมของ ผู้ค้าปลีก ผู้ค้ารายย่อย เกษตรกร และผู้เก็บขยะท้องถิ่นในพื้นที่คาราวาง ประเทศอินโดนีเซีย

วัตถุประสงค์ที่ ๒ วิเคราะห์วิธีการที่เป็นไปได้ในการกำจัดซากบรรจุภัณฑ์เคมีที่ทำจากพลาสติก โดยใช้หลักเกณฑ์ ๔ ประการ

วัตถุประสงค์ที่ ๓ ออกแบบระบบการจัดการในการกำจัดซากบรรจุภัณฑ์เคมีให้เหมาะกับเขตคาราวาง

วิธีการดำเนินงาน

ในการบรรลุวัตถุประสงค์ที่หนึ่ง คณะผู้วิจัยได้คิดคำถามสัมภาษณ์เป็นภาษาอังกฤษ และแปลเป็นภาษาอินโดนีเซียด้วยความช่วยเหลือจากนักศึกษาของมหาวิทยาลัยจาการ์ตา (State University of Jakarta) จำนวนเจ็ดคน เพื่อให้ผู้ถูกสัมภาษณ์ซึ่งเป็นคนท้องถิ่นในเขตคาราวางสามารถเข้าใจ และสามารถสื่อสารได้ง่ายยิ่งขึ้น รวมทั้งผู้วิจัยก็จะได้รับข้อมูลที่ถูกต้องมาทำการวิเคราะห์ต่อไปด้วย ทั้งนี้ การสัมภาษณ์เป็นการสอบถามรายบุคคล โดยคำถามที่ใช้เป็นคำถามปลายเปิด หลังจากนั้น คำตอบทั้งหมดได้ถูกแปลกลับมาเป็นภาษาอังกฤษ คณะผู้วิจัยได้ทำการสัมภาษณ์ในสามหมู่บ้าน ได้แก่ ศิรามายา จาธิซารี และวาดัส และผู้ถูกสัมภาษณ์ ได้แก่ ผู้ค้าปลีกจำนวน ๓ ราย ผู้ค้ารายย่อย ๒ ราย หัวหน้าเกษตรกร ๑๑ ราย และผู้เก็บขยะ ๕ ราย

เพื่อบรรลุวัตถุประสงค์ที่สอง คณะผู้วิจัยทำการวิเคราะห์วิธีกำจัดซากบรรจุภัณฑ์พลาสติก ๔ วิธี อันได้แก่ การนำกลับมาใช้ซ้ำ (reuse), การนำกลับมาใช้ใหม่ (recycle), การเผาเพื่อเป็นเชื้อเพลิงในกระบวนการผลิตปูนซีเมนต์ (co-processing), และฝังกลบ (landfill) ซึ่งอ้างอิงจากหลักเกณฑ์ ๔ ประการ ได้แก่ ประสิทธิภาพของวิธีการนั้น ๆ มาตรการและกฎหมายที่รองรับ ความสามารถในการป้องกันผลิตภัณฑ์ปลอมแปลง และผลกระทบต่อสิ่งแวดล้อม ชุมชน รวมถึงบริษัทผลิตสารกำจัดศัตรูพืช

เพื่อบรรลุวัตถุประสงค์สุดท้าย คณะผู้วิจัยมีการนำข้อมูลที่ได้จากวัตถุประสงค์แรก และวัตถุประสงค์ที่สองมารวมกัน เพื่อออกแบบระบบการจัดการซากบรรจุภัณฑ์ให้เหมาะกับเขตคาราวาง

ผลการดำเนินงาน

ภายหลังจากการบรรลุวัตถุประสงค์ที่ ๑ และ ๒ ที่ระบุไว้ก่อนหน้านี้ ทำให้คณะผู้วิจัยได้ข้อมูลดิบมาก่อนที่จะได้วิเคราะห์และค้นพบประเด็นสำคัญ ซึ่งประเด็นเหล่านั้นได้ให้ข้อมูลที่เป็นประโยชน์ในการออกแบบโปรแกรมการจัดการซากบรรจุภัณฑ์

จากการลงพื้นที่สัมภาษณ์ ทำให้คณะผู้วิจัยทราบว่าการจำแนกสารกำจัดศัตรูพืชปลอมไม่ใช่ปัญหาหลักในเขตคาราวาง เนื่องจากผู้ค้าปลีก ผู้ค้ารายย่อย และเกษตรกร สามารถแยกแยะระหว่างผลิตภัณฑ์ของจริงกับของปลอมได้ อย่างไรก็ตาม ยังไม่มีผู้ค้าปลีกหรือรายย่อยรายใดบอกวิธีการกำจัดซากบรรจุภัณฑ์แก่เกษตรกร ยิ่งไป

กว่านั้น แม้ว่าเหล่าหัวหน้าเกษตรกรจะทำการล้างบรรจุภัณฑ์ด้วยน้ำเปล่าสามครั้ง ตามด้วยการเจาะรูที่ขวดสารกำจัดศัตรูพืช แต่เรายังไม่สามารถระบุว่าเกษตรกรรายย่อยได้ปฏิบัติในแนวทางนั้นเช่นกัน

เมื่ออ้างอิงจากข้อมูลในการสัมภาษณ์ ทำให้คณะผู้วิจัยได้ค้นพบความเชื่อมโยงระหว่างบุคคลต่าง ๆ ที่เกี่ยวข้องกับบรรจุภัณฑ์ของสารกำจัดศัตรูพืช ตั้งแต่โรงงานผลิต จนถึงบุคคลสุดท้ายที่คณะผู้วิจัยยังไม่สามารถระบุได้ อีกทั้งยังพบว่ามีบรรจุภัณฑ์ที่ผู้เก็บขยะสามารถเก็บได้คิดเป็นเป็นเพียงร้อยละ ๓ ของจำนวนซากบรรจุภัณฑ์ที่เกษตรกรใช้แล้วทิ้ง

จากการวิเคราะห์วิธีที่เป็นไปได้ในการกำจัดซากบรรจุภัณฑ์เคมีเกษตร คณะผู้วิจัยพบว่าการนำกลับมาใช้ใหม่ (recycle) และการเผาเพื่อเป็นเชื้อเพลิงในกระบวนการทำปูนซีเมนต์ (co-processing) เป็นสองวิธีที่ดีที่สุดในการจัดการซากบรรจุภัณฑ์ภายในพื้นที่คาราวาง อีกทั้งเมื่อทำการวิเคราะห์ข้อมูลจากวัตถุประสงค์ข้อแรก ทำให้เราทราบถึงจุดที่เกิดการสูญหายของซากบรรจุภัณฑ์ คือพ่อค้าคนกลางและผู้เก็บขยะ ดังนั้น เราจึงปรับกระบวนการโดยเปลี่ยนให้ผู้ค้าปลีกมาเป็นผู้เก็บซากบรรจุภัณฑ์แทน

สุดท้ายนี้ คณะผู้วิจัยเล็งเห็นว่าพ่อค้าปลีกและบริษัทกำจัดขยะควรร่วมมือกัน โดยมีผู้ขนส่งซึ่งเป็นคนของบริษัทกำจัดขยะเป็นคนจัดการดูแลตลอดการขนส่ง และนำระบบบาร์โค้ดมาใช้ในการติดตามบรรจุภัณฑ์ตั้งแต่เริ่มจัดส่งออกจากบริษัทผลิตสารกำจัดศัตรูพืช ไปจนถึงโรงงานรีไซเคิลพลาสติกหรือโรงงานปูนซีเมนต์เพื่อเพิ่มประสิทธิภาพของการจัดการ

ข้อสรุป

จากการวิเคราะห์ข้อมูล แม้ว่าคณะผู้วิจัยจะสามารถสืบหาต้นเหตุของปัญหา เลือกวิธีการกำจัดขยะที่เหมาะสม และออกแบบระบบการจัดการในการกำจัดซากบรรจุภัณฑ์เคมีได้ อย่างไรก็ตาม ระบบนี้ยังไม่สามารถนำมาใช้กับพื้นที่คาราวางในปัจจุบัน เนื่องด้วยมีข้อจำกัดจากพฤติกรรมบางอย่างของผู้เกี่ยวข้องและมาตรการทางกฎหมายของประเทศอินโดนีเซีย ดังนั้น คณะผู้วิจัยจึงสร้างข้อเสนอแนะเพื่อทำให้ระบบที่ออกแบบสามารถนำไปใช้ได้จริง

ข้อเสนอแนะ

เพื่อที่จะทำให้ระบบการจัดการในการกำจัดซากบรรจุภัณฑ์เคมีให้เหมาะกับเขตคาราวางประสบความสำเร็จ เราจึงเสนอ ๔ มาตรการที่ควรกระทำควบคู่กันไป ดังต่อไปนี้

ประการแรก การมีส่วนร่วมจากรัฐบาลเป็นสิ่งจำเป็นในการตรวจสอบระบบ รวมทั้งรัฐบาลควรรับรองว่าวิธีการล้างสามครั้ง (Triple-rinse method) จะทำให้ไม่มีสารเคมีตกค้างในซากบรรจุภัณฑ์ และเข้าสู่บริษัทกำจัดขยะได้

ประการที่สอง ควรจัดโปรแกรมการศึกษาสำหรับผู้ค้าปลีก ผู้ค้ารายย่อย และเกษตรกรเพื่อให้เข้าใจถึงผลกระทบของผลิตภัณฑ์ปลอมแปลง และเรียนรู้เกี่ยวกับแนวทางการปฏิบัติที่ถูกต้องในการจัดการซากบรรจุภัณฑ์

ประการที่สาม ควรมีระบบติดตามบรรจุภัณฑ์ เพื่อให้แน่ใจว่าจะไม่มีบรรจุภัณฑ์สูญหายในแต่ละขั้นตอนของระบบการจัดการ

ประการสุดท้าย ควรมีมาตรการสร้างแรงจูงใจ เพื่อกระตุ้นการมีส่วนร่วมของผู้เกี่ยวข้องในระบบการจัดการ

Table of Content

List of Figures

List of Tables

Authorship

Section Title	Written by	Reviewed by
Abstract	Tarinee, Passachol	Tanaporn
Executive Summary	Passachol	All
บทสรุปผู้บริหาร	Pichayathida, Tanaporn, Tarinee	Passachol
Acknowledgements	Passachol	Tanaporn
Chapter 1: Introduction	All	All
Chapter 2: Background	Passachol	Tanaporn
2.1 Background information on CropLife organization	Passachol	All
2.2 Karawang Regency	Tarinee	All
2.3 Background Information on retailers/kiosks, farmers, and containers collectors	Pichayathida	All
2.4 Indonesian legal regulations on pesticide containers management	Passachol	All
2.5 Empty pesticide containers management methods	All	All
2.5.1 Pre-treatment method: Triple-rinse	Pichayathida, Tanaporn	Passachol
2.5.2 Recovery and disposal methods	All	All
Reuse	Passchol	All
Recycle	Tarinee	All
Co-Processing	Pichayathida	All
Landfill	Tanaporn	All
2.6 Case studies on empty pesticide containers management program	All	All
2.7 Waste management companies	Pichayathida	Passachol, Tanaporn
Chapter 3: Methodology	Passachol	Tanaporn
3.1 Objective 1	Passachol	All
3.2 Objective 2	Pichayathida	All
3.3 Objective 3	Tanaporn, Tarinee	Passachol

Chapter 4: Results	Tarinee	Tanaporn
4.1 Understanding local Indonesian retailers/kiosks', farmers', and collectors' behavior	Passachol, Tarinee	All
4.2 A summary of possible recovery and disposal methods for the empty plastic pesticide containers in Karawang Regency	Pichayathida, Tanaporn	All
4.3 Integrate study data and design a management program for empty plastic pesticide containers in Karawang Regency	Passachol, Tarinee	All
Chapter 5: Conclusion and Recommendations	Passachol	All
Conclusion	Tarinee	Passachol
1. Involvement of the government is necessary to implement the management program successfully	Passachol, Tanaporn	All
2. There should be an education program for retailers, kiosks, and farmers	Tanaporn	Passachol
3. There should be a tracking system to record and check for pesticide containers	Passachol	All
4. Incentives should be applied to encourage the participation of relevant stakeholders; retailers, kiosks, and farmers	Passachol, Pichayathida	All
Areas for Future Research	Pichayathida	Passachol
Deliverables	Passachol	All
References	Tanaporn	All
Appendices	All	All

Chapter 1: Introduction

The term “pesticide” covers a wide range of chemical substances including insecticides, fungicides, herbicides, plant growth regulators and others. Pesticides have numerous benefits: they are used to control pests, increase food production and prevent diseases. In the absence of pesticides, food production could decrease by approximately 40 to 50 percent impacting sustainable agriculture and thus food scarcity. However, wherever pesticides are used, empty containers are created. Without a good control of wastes in the form of empty pesticide containers, pesticide containers and residues in the containers can contaminate the environment, which will eventually post a threat on human health and even cause deaths.

The reason why this project was conducted in Karawang is its location. Karawang is accessible from Jakarta and suitable for our time limit of one-month period. Moreover, Karawang is the second largest rice-planting area on Java Island; the farmers here use a lot of pesticides and thus creating a lot of empty pesticide containers. The project problem is how to manage the disposal of empty plastic pesticide containers by local farmers in Karawang area. Karawang is also one of the major areas faced with counterfeit pesticide products. When farmers dispose the empty pesticide containers with the company’s brand label directly into trash or sell it to collectors, the containers are collected and sold to illegal companies who refill the containers with diluted or fake formulation of pesticides. This affects the reputation of the pesticide manufacturing companies.

There are many countries around the world which have come up with a pesticide containers waste management program. Indonesia is also one of them. CropLife Indonesia has developed a program called “Stewardship”. The program started 18 years ago. One of the actions undertaken by this program was educating Indonesian farmers through various training programs and encouraging partnerships between the government, non-governmental organizations, and the industries. However, currently in Indonesia, the empty pesticide containers management program has not been implemented due to legal ambiguity and lack of interest in actually putting the program into practice on the part of the farmers despite having received training.

In order to design a suitable management, we decided to observe and analyze the local farmers’ behavior along with the local retailers/kiosks and collectors in Karawang to gain an insight into their perception of the issue. Additionally, we also conducted an identification and analysis of possible recovery and disposal methods as well as a study on legal regulations. When we have a better understanding on all the

stakeholders, waste management methods, and the legal regulations, we will be able to design a management program for empty plastic pesticide containers in Karawang.

A fully integrated management program of pesticide containers will take a number of years. The goal of this project is to come up with a management program that focuses on the collection, transportation, and recovery or disposal methods of the pesticide containers in Karawang. This goal will be achieved by understanding retailers/kiosks', farmers', and collectors' behavior. Studying about the capability, relevant legal regulations, counterfeit product prevention, and impact of each recovery and disposal method will help us to eliminate the inappropriate ones. Finally, analyzing the collected data will provide enough information that can be used to design a suitable Management Program for Empty Plastic Pesticide Containers in Karawang Regency.

Chapter 2: Background

In order to do this project properly, we need to study the background and collect data of the relevant stakeholders.
Therefore, the background chapter is composed of:

(1) The background of the CropLife association
(2) Introduction of Karawang Regency
(3) Information of retailers/kiosks, farmers, and collectors
(4) Information on the legal regulations of Indonesia that are related to pesticide containers management
(5) Information on possible empty plastic pesticide containers recovery and disposal methods
(6) Case studies on empty pesticide containers management programs across the world
(7) Information on waste management companies

2.1 Background information on CropLife association [1]

CropLife Indonesia is a non-profit association which consists of six agrochemical companies including: Syngenta, BASF, FMC, Nufarm, Bayer - who has merged with Monsanto, and Corteva – who is a merging of DOW and DuPont. The association aims to build a relationship between farmers and pesticide industries. The association's goals are to help farmers produce sufficient amount of food for a growing population on less land with greater efficiency, to obtain a safe food supply through safe food production and farming process while minimizing environmental impact. CropLife Indonesia is divided mainly into five divisions and this project was developed under the "Stewardship Division".

2.1.1 Stewardship Division[2]

Stewardship is a life cycle approach to product management. It is a responsible and ethical way to manage crop protection products commencing from their discovery, development, their use and finally to the disposal of any waste. This type of management program is a contingency program that can be changed according to the situation.

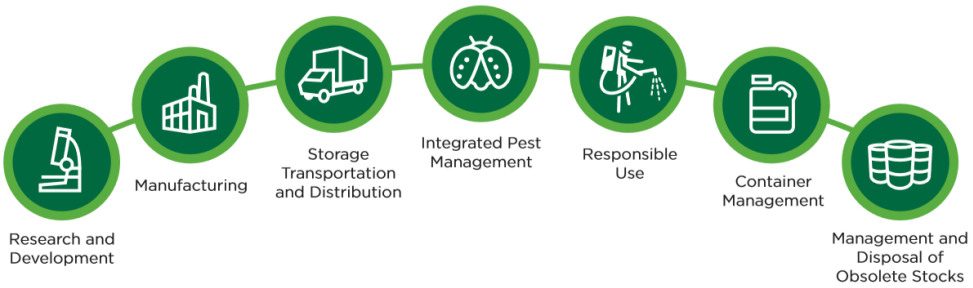

Figure 1: *Stewardship diagram*[2]

2.2 Karawang Regency

Karawang is one of the Regencies that is located in West Java province of Indonesia. The area of Karawang Regency is 165,200 hectares[3], with rice planted over an area of 95,902 hectares[4].

According to the 2014 census in January, there are 2,288,254 people living in Karawang[3]. The three villages that our project will cover include Cilamaya, Wadas, and Jatisari.

Figure 2: *Location of Kawawang Regency and three villages: Cilamaya, Wadas, and Jatisari*

2.2.1 Main avocations

Karawang is the location of several industrial areas. It is also well-known in agriculture as a West Java rice granary[5]. Hence, the largest proportion of its citizens work in the agricultural sector.

2.2.2 Income of the farmers in Karawang Regency

According to the Indonesian Scientific Repository, the selling price of unhusked rice crops received by farmers ranges between Rp 2,200 to Rp 3,800 per kilogram[6].

2.2.3 Counterfeit pesticides in Karawang Regency

In large scale agriculture, it is impossible to avoid chemicals or pesticides used for protecting crops. One of the main problems on pesticide usage, apart from their health and environmental effects, is counterfeit products. Counterfeit products are the main negative side effect of mismanagement of empty pesticide containers in Karawang. After farmers use up the pesticide solution, some of them do not puncture or compress the containers; hence, the containers might be collected and refilled with other substances and then be resold. This practice can be found in the agriculture sector where the Rp 650 billion pesticide market attracts fake manufacturers.

According to Alghienka Defosandi of Dow Indonesia[7], Companies facing this issue feel some of their products are no longer trusted by farmers, who have come to believe they have bought pesticides with no quality.

2.3 Background Information on retailers/kiosks, farmers, and containers collectors

Apart from CropLife Indonesia who is the main stakeholder in this project, there are other partners - including retailers and kiosks, farmers, and collectors, who are involved and have direct impact toward the life cycle of the product management program. To design a suitable management program, we need to understand who the three parties are, and what positions or roles they play in this cycle.

- **Retailers and Kiosks**

Retailers are the ones who purchase pesticides directly from the official company dealers and retail to the kiosks or sometimes directly sell to the farmers. From then, kiosks, which are the smaller stores, will purchase the pesticides from retailers and resell to farmers again.

- **Farmers**

Farmers are the ones who purchase the pesticides from retailers or kiosks, apply the pesticides, and then dispose of the empty containers. The way that farmers chose to dispose of their empty pesticide containers after usage will have a significant impact on our project.

We found that in Karawang, only the key or the head of the farmers own the cultivation land. The size of land that one key farmer owns is around five to six hectares and there are sub-farmers who work for the key farmers. One key farmer usually has twenty to twenty-five sub-farmers under their supervision and approximately 50 to 70 percent of the sub-farmers will listen to what the key farmer said.

- **Containers collectors**

Containers collectors are the people who collect empty pesticide containers from the farmers. The collectors usually buy empty containers from farmers and sell them as plastic for recycling or for other purposes.

2.4 Indonesian legal regulations on pesticide containers management

The regulations about pesticides involve several Ministries in Indonesia. However, those Ministries have issued regulations that disagree with one another; some were related but others contradicted each other.

2.4.1 Ministry of Agriculture

The Ministry of Agriculture has classified a pesticide solution as a Hazardous product but has not yet defined the category for an empty pesticide container. The methods suggested for handling any kind of empty containers were to bury them or what they called “Landfill” or burn them. However, these suggested methods were contradictory to the Ministry of Environment and Forestry since burying or burning containers will contaminate the soil and air. More information can be found in Appendix B.

2.4.2 Ministry of Environment and Forestry (MoEF)

Under the Ministry of Environment and Forestry, the pesticide solution was categorized as Hazardous and Toxic Material. There is a regulation called PP101 (see Appendix B) that refers to Hazardous Wastes. It states how to deal with Hazardous and Toxic Wastes from the beginning up to the end of the process, including labeling, transportation, and methods of management: the label must include pictograms about how to handle pesticide containers, the transportation company must have a license to transport Hazardous Wastes, and the waste management companies must be ones that are certified by the government.

Nevertheless, PP101 only covers the wastes from the perspective of industries or businesses, and does not cover the wastes from the end-level user, such as the empty pesticide containers disposed by farmers. Moreover, even though PP101 states about Hazardous Wastes, it has not yet classified which wastes are Hazardous Wastes. Thus, technically, empty pesticide containers have not yet been defined by this regulation.

There is also another regulation from MoEF that is intended to regulate all types of chemicals as Hazardous and Toxic Wastes or what is called “B3 Wastes”. It also includes the classification of Hazardous Wastes. However, this regulation is still

in the draft form and therefore has not yet been passed as a law in Indonesia. More information about “B3 Wastes” regulation can be found in Appendix B.

2.4.3 Ministry of Industry

Ministry of Industry is the agency who takes an advanced step by linking the PP101 regulation from MoEF to the waste management companies. They have granted certificates to several companies in Indonesia, including PPLi and Holcim which will be further mentioned in Section 2.7 (Waste management companies). Furthermore, none of the pesticide manufacturers in Indonesia have been granted this certificate, which is the reason why pesticide manufacturing companies are not able to handle empty pesticide containers by themselves. More information can be found in Appendix B.

2.5 Empty pesticide containers management methods

There are several recovery and disposal methods that can be used to manage empty plastic pesticide containers. Figure 3 shows the Hierarchy of Waste Management[8] which ranks the methods from the most to the least desirable. This means that, if the top rank methods can be used, then the wastes should be handled using that method. We skip avoidance and minimization of pesticide usage since these two methods will decrease the crop yield. For incineration, it is already included as a part of co-processing method. Lastly, for Chem-Physical Pre-Treatment, this method is not currently available in Indonesia.

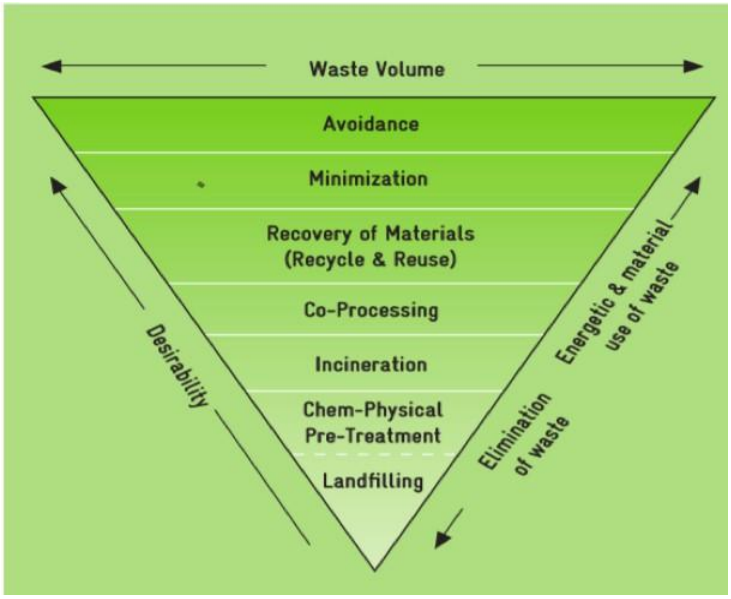

Figure 3: *Hierarchy of Waste Management*

2.5.1 Pre-treatment method: Triple-rinse[9]

Before performing any kind of disposal methods, the triple-rinse must be conducted. Triple rinsing with water of an empty pesticide container is the recommended cleaning method used worldwide. With proper rinsing, it can help remove 99% or more of the pesticide residue[10] from the empty containers. More details on directions on and effectiveness of a triple-rinse can be found in Appendix C.

2.5.2 Recovery and disposal methods

Reuse

In some countries, such as the United States[11] and the United Kingdom[12], some types of empty pesticide containers, particularly those with a triple-rinse, are allowed to be refilled with liquid pesticide. However, the containers must be specifically manufactured in order to pass the requirements of being a refillable container in that country. In addition, the refill process must be conducted by the original manufacturers of that pesticide only, meaning that the manufacturers must find a way to collect back their containers in good condition.

Recycle

Recycling is the process that melts and pelletizes the plastic wastes into plastic pellets. In order to recycle plastic pesticide containers, special treatment or at least a triple-rinse must be undertaken. The containers must undergo a risk analysis to show that there are no unacceptable risks to humans and the environment for the repeated use. The risk analysis should be undertaken by the individual country's program, local government, or other competent private or public organizations[13]. If the risk is too high, those containers will be rejected by the supervisory organization. According to Food and Agriculture Organization of the United Nations (FAO)[14], it mentions that the plastic pellets that come from the recycling process of empty plastic pesticide containers can be recycled for specific non-food use only.

Co-Processing[15]

Co-processing is the technique that simultaneously recovers the energy and recycles the mineral materials from the waste within one step. This occurs in one single industry – the cement industry. The process is carried out in cement kilns under a very high temperature for a specific period of time. As a result, the formation of toxic gas (dioxins and furans) is prevented. Moreover, there is no residue or ash left from Co-processing because all materials will be fed into the kiln and become part of the cement;

(1) Materials which contain calories (such as waste plastic and waste oil)[8] are categorized as an alternative fuel (AF), to use as a fuel.
(2) Materials which contain both calories and minerals (such as calcium, silica, alumina, and iron) are categorized as alternative raw materials (AR), to replace the natural substances like clay, shale and limestone in the cement production process.

As a result, 100% of the waste input is recycled or recovered without producing any additional residue that needs to be buried.

Landfill

Landfill is a site for disposing of waste materials by burying them in the earth. Landfill is the most widely utilized option in solid waste management[16]. However, there is some limitation with landfill. For instance, the geography of the land must be studied in order to choose the areas that will not be affected by earthquakes because the hazardous substance could leak out to the environment.

- *A Case study of sanitary landfill in DAVAO CITY, Philippines*

According to Safeopedia[17], sanitary landfill was used to prevent waste from presenting an environmental hazard through gas or leachate* pollution. However, in Davao City, Philippines[18] the Environmental Management Bureau confirmed a leak coming from a sanitary landfill in New Carmen, where they saw traces of leachate spreading all over the landfill and even reaching the waters of Matina Pangi river. The leakage posed a significant threat to area residents and the environment.

- *A case study from Food and Agriculture Organization of the United Nations (FAO)*

According to the Food and Agriculture Organization of the United Nations (FAO)[14], landfill is one of the unrecompensed disposal methods. Because many countries that buried pesticides in the past are now experiencing severe environmental contamination and facing huge costs to recover the pesticides and to mitigate damage to the environment and public health.

2.6 Case studies on empty pesticide containers management program

Management programs were selected based on commonalities of the geographical area and CropLife Indonesia recommendations. Since our project is based in Indonesia, the selected management program mostly came from countries in Asia. Some of them have succeeded, but some have not; hence, we are interested to know what made those programs successful as well as the parameters that made other programs unsuccessful. The success of the program can be defined by the close and

* Leachate is the liquid that comes from landfills and poses a threat to water sources

dedicated cooperation from all stakeholders, sufficient cost, sustainability of the program, and impact towards the environment.

2.6.1 Successful management programs

Out of five selected management programs, there are two management programs that could be feasible for Indonesia in the future; therefore, we are interested in looking into these two programs in more detail. (More information is in Appendix D)

Taiwan[19]

In Taiwan, the method called "Triple-rinse" has been approved by the government. When the farmers used up all of the pesticide solution, the containers had to be rinsed using the triple-rinse method. As a result, the empty pesticide containers in Taiwan were not classified as Hazardous Waste but considered as normal household waste instead. Therefore, farmers can dispose the containers into the regular trash, which is eventually picked up by the government garbage truck. The cost to manage empty pesticide containers comes from the tax that is paid by all pesticide manufacturing companies. This tax is calculated using a percentage of the profit that the companies gain in each month or quarter.

Brazil[20]

In Brazil, there is a program called "Campo Limpo" which states by law that farmers are required to properly rinse (pressure or triple-rinse) all containers and puncture them to prevent any possible reuse. Furthermore, the empty pesticide containers in Brazil are classified as Non-Hazardous Waste[21]. The management program in Brazil is successful because the government has educated not only farmers but also the retailers, to understand the hazard of empty pesticide containers. Thus, all containers are required to be rinsed using the triple-rinse method before disposing them into a regular trash after which the empty containers will be sent to the recycling company to make corrugated tubes, cables, construction materials, and even a new container for crop protection product. As a result, the objective of recycling is to generate value for the containers and reduce the cost of the system. However, in order to succeed, the government states that it needs willingness from all of the stakeholders, not only the farmers, to make this program successful.

2.6.2 Unsuccessful management program

One of the unsuccessful case studies comes from Vietnam. The study shows the reasons why this program was not successful. Firstly, farmers did not want to apply the Integrated Pest Management (IPM) in their own fields when it was not

applied in surrounding fields. Secondly, low net profit was realized when applying IPM, especially for farmers owning small fields. As a result, 96% of farmers in An Long and 45% in Ba Lang discarded empty pesticide containers directly into the fields which led to water contamination[22].

2.7 Waste management companies

According to the regulations, only certified companies are allowed to handle empty pesticide containers. According to CropLife Indonesia, two companies are recommended by the government.

2.7.1 Background information on Holcim[23]

Holcim Indonesia is a cement company which provides waste management solutions through Geocycle. Holcim-Geocycle offers waste disposal using co-processing technology. Holcim has two cement kilns which can co-process 10 tons of mixing waste (hazardous and non-hazardous wastes) per hour, approximately 0.5-1 tons are plastic containers.

2.7.2 Background information on PPLi[24]

PPLi or PT. Prasadha Pamunah Limbah Industri, is a certified Indonesian company who manages all kinds of industrial waste. For pesticide drums, they can perform the collection, treatment and recycling service that covers all areas of Java island. However, they are still not able to collect waste directly from the end-level users due to the PP101 regulation.

Currently, the pesticide drums from industrial companies can be recycled at PPLi. Firstly, they provide pre-treatment method by washing the drums and testing the last water in order to make sure that the drums are safe enough before entering into the recycling process. The second step is crushing the drums using the crusher, then putting them into the plastic granulator to make plastic pellets. PPLi has the capacity to recycle 80 drums (each drum is 200 liters in volume and weight 10 kilograms) per cycle, meaning that they can recycle 3.2 tonnes of plastic containers per week.

Chapter 3: Methodology

The goal of our project was to design a Management Program for Empty Plastic Pesticide Containers in Karawang Regency. In order to achieve this goal, we developed the following research objectives:

1. To understand the behavior of the local Indonesian retailers/kiosks, farmers, and collectors.
2. To analyze possible empty plastic pesticide containers recovery and disposal methods based on the criteria.
3. To design a management program for empty plastic pesticide containers in Karawang Regency

3.1 Objective 1

To understand the behavior of the local Indonesian retailers/kiosks, farmers, and collectors

The first objective served to gain a deep understanding of the three parties, which were local Indonesian retailers/kiosks, farmers, and collectors in Karawang Regency of West Java.

The first party we interviewed was the local retailers/kiosks who sold the pesticides. We interviewed them using the list of questions shown in Appendix E-1. The questions were designed to gain information about the pesticides that they sold, awareness of the counterfeit product, and whether the retailers have ever been educated about an empty pesticide management program.

We also interviewed the second party, the local farmers, using the list of questions in Appendix E-2. The aim of this interview was to understand not only their behavior but also their practices, beliefs, and knowledge towards pesticides, counterfeit products, and disposal of empty pesticide containers. Consequently, we would be able to understand how much effort they were willing to make and be a part of the management program that we would propose.

The last party was the containers collectors. The interview questions can be seen in Appendix E-3. We interviewed them in order to know what happened to the containers after they had collected the containers from the farmers.

We analyzed the behavior of the retailers/kiosks, farmers, and collectors in order to track the flow of pesticide containers. This was done so that our group will be able to design a management program that complemented their routine rather than asking them to completely change their behavior.

3.2 Objective 2

To analyze possible empty plastic pesticide containers recovery and disposal methods based on the criteria

The aim of the second objective was to analyze possible recovery and disposal methods for handling empty plastic pesticide containers. From the literature review, we found that triple-rinse was the pre-treatment method that had to be performed before the containers entered into any kind of recovery and disposal process. The other four possible waste management methods that must be analyzed were: reuse, recycle, co-processing, and landfill. After we looked into the successful management programs (see Appendix D), there were four main areas that had to be considered in order to make the management program became successful; hence, we created a set of criteria based on those areas for analyzing the waste management methods.

- **Capability**

The capability was not only about the capacity of recovery and disposal methods but also included feasibility in terms of geography, collection, transportation, and limitation(s) for each waste management method.

- **Regulation**

The chosen recovery and/or disposal method(s) had to be consistent with the legislation. The regulations in Indonesia that are related to pesticides had to be considered to help evaluate the feasibility of each waste management method.

- **Counterfeit prevention**

Since the counterfeit product is the most severe side effect of inappropriate handling of empty pesticide containers, the chosen method(s) had to be able to help to prevent counterfeit products; for example, a method that involves puncturing, compressing, or cutting the empty pesticide containers.

- **Impacts**

A comparison of the positive and negative impacts of each waste management method had to be undertaken in order to choose the method that would provide the best result for companies, communities, and the environment.

3.3 Objective 3

To design a management program for empty plastic pesticide containers in Karawang Regency

After we had discovered the flow of pesticide containers by analyzing local parties' behavior, we could find the way to connect each party together in order to design a management program that could track the pesticide containers from the moment that the pesticides were sold by the retailers until they reached the waste management companies. Furthermore, a system to record and check for the containers

would be applied along the flow. As a result, with this program we would be able to prevent counterfeit products because it would not be possible for empty pesticide containers to leak out to the counterfeit product companies.

For the waste management methods, firstly, we had to identify which recovery and/or disposal method we were going to use. According to the Objective 2, we could select the most suitable recovery and/or disposal method by comparing information of each method regarding the criteria. After that, we would be able to suggest the waste management companies that capable of processing the empty plastic pesticide containers under the selected waste management method(s).

As a result, we were able to come up with a management program for empty plastic pesticide containers in Karawang Regency by integrating the flow of pesticide containers in Karawang with the waste management companies through any transporter that was certified by the government along with the recording and checking system.

Chapter 4: Results

In this chapter, we discussed the findings from our interviews with local Indonesian retailers/kiosks, farmers, and collectors as well as the findings from possible waste management methods. Then, we put together different groups of collected data to design a management program for empty plastic pesticide containers in Karawang Regency.

4.1 Understanding local Indonesian retailers/kiosks', farmers', and collectors' behavior

We carried out the interviews in three villages of Karawang Regency, which were Cilamaya, Wadas, and Jatisari. Three retailers, two kiosks, eleven key farmers, and nine collectors were interviewed. The findings below illustrate the key information we received from each party during the field interviews.

Finding 1: Counterfeit product identification was not a problem in Karawang.

For the retailers and kiosks, all of them were able to distinguish between the authentic and counterfeit products by looking at the packaging, its smell, and price. The counterfeit containers usually had no plastic seal on the cap and the price was also a bit cheaper than the authentic one. For the smell, they said that it smelled different than the authentic product.

For the farmers, all of them had come across the counterfeit products. Most of them could distinguish between the counterfeit and authentic products by smelling, and observing the concentration of the solution. They also knew that it was likely to be a counterfeit product if it was door to door selling. In addition, if they were uncertain about the products, they would simply apply the pesticide and see whether it could prevent pests or not. Furthermore, when they realized they had purchased a counterfeit product, they would return it to the place where they had bought it to get a refund.

Finding 2: None of the retailers and kiosks told the farmers how to deal with empty pesticide containers.

Based on the interviews, all of the retailers and kiosks said that they had fully attended the training sessions (see Appendix F-1). Most training sessions were hosted by pesticide manufacturing companies. They learned about the new product information and the best practice of using pesticide, then they shared this information with farmers. However, none of these training sessions that they had participated in mentioned how to deal with the empty pesticide containers; thus, they did not have any information and knowledge about it. In addition, they assumed that farmers

already knew about how to deal with the empty containers after used, so they did not share this kind of information with the farmers.

Finding 3: Most key farmers knew how to properly triple-rinse and puncture the containers, but not be certain for the sub-farmers.

After finishing the pesticide solution, 91% of key farmers performed the triple-rinse method (see Appendix F-2: Rinsing) without knowing what this term meant. They did the three rinses simply because they wanted to use the last drop of pesticide in the container. Moreover, they punctured the empty pesticide containers because they wanted to help prevent counterfeit products. While all of the key farmers performed well, we were not certain whether the sub-farmers did.

Finding 4: Farmers used different ways to dispose of empty pesticide containers.

Most farmers exchanged the empty pesticide containers for soap, cooking oil, and glasses with the first middlemen or collectors while the rest sold them (see Appendix F-2: Handling methods). Based on the interviews, the selling price fell between Rp 1,000 - Rp 1,500 per kilogram of the punctured containers. However, one key farmer said that some of his sub-farmers sold the un-punctured empty pesticide containers for Rp 10,000 per bottle.

Finding 5: Farmers attended a training session when it was beneficial to them.

Around 91% of the farmers whom we interviewed had attended the training sessions (see Appendix F-2: Training session attendance by farmers). The ones who attended said that they only did so if they received something in return, such as knowledge that would be beneficial to them or some kind of rewards. The beneficial knowledge that they mentioned was about the dosage of pesticide, treatment of soil, and information about new pesticide products and others (see Appendix F-2: Types of training session) The rewards were seeds and certificates of attendance from the government or pesticide manufacturing companies.

Finding 6: The number of empty pesticide containers collected by the collectors was not the same as the farmers disposed of.

Based on the interviews, one farmer used around sixteen 100 mL plastic pesticide containers per month. Hence, the number of empty plastic pesticide containers that were disposed of by farmers in Karawang Regency was 30.2 tonnes/month. (See Appendix G-1 for calculation)

However, most of the collectors could collect around 50-100 kilograms of all kinds of empty containers per day, and about 0.5% of the collected containers were pesticide containers. Hence, the number of empty pesticide containers that were

collected in Karawang was 0.75-1.50 tonnes per month (see Appendix G-2 for calculation). When compared to the number that farmers discarded, only about 3% of the empty pesticide containers were collected back.

Finding 7: The chain of empty pesticide containers in Karawang involved pesticide manufacturing companies, dealers, retailers/kiosks, farmers, collectors, and middlemen. The final stakeholder in the chain could not be determined and was therefore unknown.

Once the pesticides came out of the manufacturing companies, they would go through the dealers. Then, the dealers would deliver to retailers. Some retailers sold pesticides directly to the farmers, some sold to kiosks.

After the farmers had bought and used up the pesticide solution, they either sold or exchanged the empty pesticide containers for soap, cooking oil, or glasses with the first middlemen or collectors. First middlemen were people who traded between farmers and collectors. They went directly to each farmer's house to collect the containers. After that, the first middlemen sold the empty pesticide containers to collectors. The compensation that collectors and first middlemen gave to farmers can be seen in Figure 4.

Then, there were second middlemen who came to the collectors and bought all the containers. This was when we lost track of the empty pesticide containers since we could not find out who the second middlemen were and where they sent the containers to. The flow of empty pesticide containers in Karawang can be seen in Figure 5.

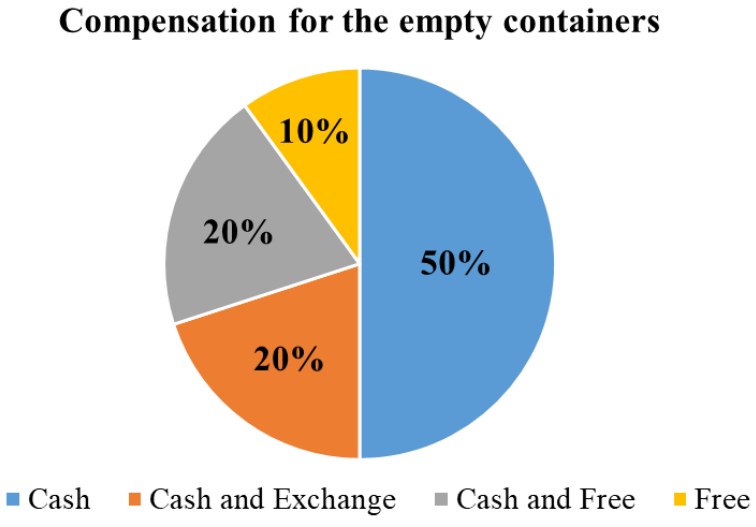

Figure 4: *Compensation for the empty pesticide containers*

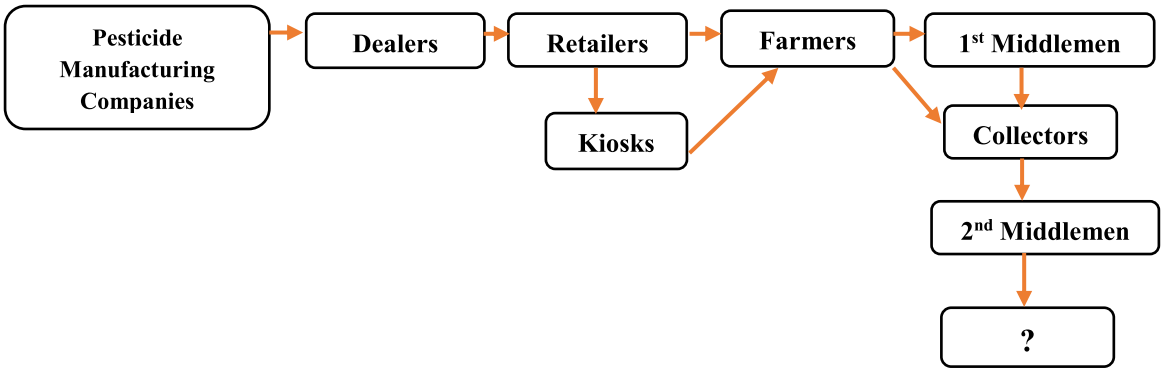

Figure 5: *A current flow of empty pesticide containers in Karawang*

4.2 A summary of possible recovery and disposal methods for the empty plastic pesticide containers in Karawang Regency

Through our background research, we chose four possible recovery and disposal methods; including reuse, recycle, co-processing, and landfill. In this section, we analyzed the information of each possible waste management method based on the four criteria that we had come up with as shown in the Methodology Chapter in order to consider the advantages and disadvantages as well as the feasibility of proceeding with implementing a used containers management program in Karawang.

Finding 8: All four waste management methods have some limited capability.

For landfill, there are several parameters that must be taken into consideration before making a decision about where to do the landfill, including geography, climate, and the geology of the area. For example, Indonesia faces a lot of earthquakes which can damage the landfill and cause toxic waste to leak out into the environment.

For reuse, this method requires a large capacity when transporting. Since the bottles must be collected back in a good condition, it would take up more space than other methods, and companies need to pay more for the cost of transportation. Moreover, there is a limitation due to the difficulty in the collection process since the containers must be separated according to color, size, material, and brand. Hence, this method is very costly and hard to carry out.

In co-processing, the wastes must contain calories (hydrocarbon) or minerals, such as calcium, silica, alumina, and iron in order to be able to use this method.

Lastly, for recycling, the plastic pellets which are the product of the recycling process of empty plastic pesticide containers cannot be used to make any new product that involves food.

Finding 9: Landfill is the only method that is recognized by law when it comes to the handling method for empty pesticide containers from end-level users.

The Ministry of Agriculture suggests that any kind of empty containers should be disposed of in a landfill or by burning. Hence, the landfill method is approved by the government, and it can be used to handle empty pesticide containers from end-level users, such as farmers. However, for the reuse method, it is not mentioned by any Ministry. In addition, for co-processing and recycling, the regulations only focus on empty pesticide containers that come from industries; hence there are no specific regulations that mention these two methods when it comes to the empty pesticide containers from end-level users.

Finding 10: Reuse is the only method that cannot help prevent counterfeit products.

Landfill, co-processing, and recycling methods require puncturing, cutting, or compressing of empty pesticide containers when the farmers dispose the containers; hence, these methods can help prevent counterfeit products. The reuse method however, requires that all of the pesticide containers must be collected back in a good condition, so it cannot prevent counterfeit products.

Finding 11: Landfill provides the least benefit for containers recovery and disposal methods.

When ranking the four methods, reuse has the most positive impact since the empty containers will be collected back and refilled with the same or other substances; hence, it helps reduce wastes. Moreover, it helps the company reduce production cost. Recycling is the second-best method. Despite some steps in the process that could emit the CO_2 gas, the empty containers are still collected back and made into a new product. In third place is co-processing. Even though the empty containers are destroyed and some CO_2 gas is created in the process, at least those plastic containers can be used as fuel in the cement production process. The fourth place is landfill. Landfill does not utilize the waste at all. Moreover, if toxic wastes leak out into the environment, it can pollute the water bodies, soil, and air which will consequently have a direct impact on human health.

Criteria / Method	Capability	Regulation	Counterfeit prevention	Impact
Landfill	• Not sustainable • Limitation in geography, climate, and geology of the area	Approved by Ministry of Agriculture	Can prevent counterfeit product	- Harmful to environment and communities
Re-use	• Difficulty in collection process • Costly • Require large space for transportation	No specific regulation	Cannot prevent counterfeit product	+ Helps reduce waste + Reduces production cost
Co-processing	• Limitation on waste materials	No specific regulation	Can prevent counterfeit product	+ Utilization of waste - Emission of CO_2
Recycle	• Limitation in recycling process	No specific regulation	Can prevent counterfeit product	+ Utilization of waste - Emission of CO_2

Table 1: *Data analysis based on four criteria*

4.3 Integrate study data and design a management program for empty plastic pesticide containers in Karawang Regency

Through the background research, data analysis from field interviews, and a summary of data on waste management methods, we were able to design a suitable management program for empty plastic pesticide containers in Karawang Regency. In order to design a management program, we had to identify the problem which caused the empty pesticide containers to go off-track, identify the trackback system, choose the most suitable recovery and disposal management method(s), and integrate them together.

Finding 12: The complete management program should exclude middlemen and collectors.

From Figure 5 in Finding 7, we can see the flow of pesticide containers. The pesticide manufacturers were still able to track the pesticide containers when they were delivered to retailers and kiosks. However, after the pesticide containers were sold to the farmers, there were many gaps in the value chain which could result in losing track of the empty containers. The problematic part that allowed the empty pesticide containers to go out off-track was the first and second middlemen, plus collectors. Hence, we tried to remove them from the flow and made farmers returned the containers in the reverse direction back to the retailers instead.

Finding 13: The tracking system of the pesticide containers is needed.

The tracking system of the pesticide containers should be applied, for example, by printing the barcode on the container labels. The pesticide manufacturers would need to scan the barcode in every delivery, sale, and return steps to prevent loss of any containers in each step. As a result, there would be no leaking out of containers to counterfeit companies.

Finding 14: Recycling and Co-processing were the most suitable waste management methods for Karawang Regency.

Based on the Hierarchy of Waste Management[8], landfill is at the bottom. Moreover, it is insecure and can cause the pollution into the environment due to the waste leakage. According to the case study in the Philippines, even though it was proved that sanitary landfill would not cause any contamination to the environment, the Environmental Management Bureau of the Philippines still observed a leakage of leachate coming out [18]. Hence, we eliminated this method.

The reuse method is at the top of the Hierarchy of Waste Management and it conserves both energy and materials used in the destruction and reforming processes.

However, it is not practical for Karawang's current situation due to two main reasons. Firstly, there was no legal mandate for the whole system of the flow of pesticide. Secondly, it was not possible to prevent counterfeit products which occur from illegal refill using containers in good condition. Thus, we cannot use this method in Karawang.

For co-processing and recycling, both methods are considered to be environmentally friendly and effective methods for managing the empty plastic pesticide containers. However, these two methods have some limitations. The limitation of co-processing is that the wastes must contain calories. Since the empty pesticide containers are plastic, which are hydrocarbon and thus good fuel. For recycling, the application of plastic pellets made from the empty pesticide containers is limited to non-food products. Therefore, co-processing and recycling are the two methods that are suitable for Karawang.

Finding 15: A proper empty pesticide containers management program is needed in Karawang.

According to all of the previous findings, there were so many problems related to mismanagement of disposal of empty pesticide containers; hence, there should be a proper management program in Karawang. The flow chart in Figure 6 illustrates a management program that we had designed by integrating the behavior analysis from field interviews and the suitable waste management methods. The orange arrows in the flow chart indicate the selling process while the blue arrows indicate the returning process.

An empty plastic pesticide containers management program in Karawang will involve pesticide manufacturers, dealers, retailers/kiosks, farmers, transporters, plus recycling and co-processing companies. The manufacturers will produce, deliver, and sell pesticide containers through the dealers, retailers/kiosks, and farmers using the barcode system. When the containers are empty, the farmers must return the containers to the original store where they bought them. Then, we will remove the middlemen and collectors by making the retailers responsible for collecting the empty pesticide containers instead. After that, a transporter will come and collect the empty pesticide containers and deliver them to the co-processing or recycling companies. A full explanation of a Management Program for Empty Plastic Pesticide Containers in Karawang Regency can be seen in Appendix H.

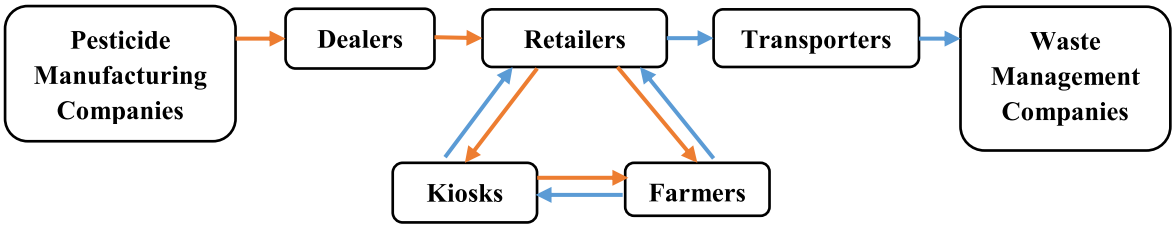

Figure 6: *A proposed flow of the empty pesticide containers in Karawang*

Chapter 5: Conclusion and Recommendations

In summary, after we performed the background research as well as analyzed the data from field interviews and waste management methods, we were able to identify the current flow of pesticide containers in Karawang, discover the problematic part that made the containers to go off-track, select the most suitable waste management methods, and design a Management Program for Empty Plastic Pesticide Containers in Karawang Regency. However, the management program cannot be implemented in Karawang's current situation due to the legal regulations and habits of the retailers/kiosks, farmers, and collectors. Hence, our team had come up with the following recommendations in order to attain our designed program.

1. Involvement of the government is necessary to implement the management program successfully.

The reason for this recommendation is based on five successful management programs from five countries, in which all of them have government participation and involvement in all activities related to the management program.

Monitor

In order to efficiently manage the program, there must be a monitoring system. For example, the government should take responsibility for monitoring the effectiveness of the training sessions. Firstly, check whether the farmers perform triple-rinse and puncture using the proper methods. Secondly, check that the retailers have collected empty pesticide containers and handed them over to the legal transporters or not.

Triple-rinse method approval

The government should give official and legal approval to the triple-rinse method and the rinsed containers should be categorized. For instance, after triple-rinse, the containers could be categorized as regular "Plastic Waste" with some limitations. The containers can be allowed to proceed under recycling and co-processing methods; however, in the recycling process, other than the plastic pellets cannot being used to produce food-related containers, furniture related products should also be avoided due to the unpleasant smell that may still remain.

2. There should be an education program for retailers, kiosks, and farmers.

In order to make the management program become successful, farmers must understand the negative impacts of counterfeit products, how it could affect them, learn the proper ways to handle empty pesticide containers and apply the knowledge in their own fields. Also, retailers, kiosks, and key farmers can play an important role to help to educate the farmers as well.

Training sessions

The education program could be a training session that is hosted by pesticide manufacturing companies. The session should teach the farmers how to properly triple-rinse and puncture the empty pesticide containers, as well as the benefits of triple-rinse; since their aim is to obtain the last drop of pesticide, the triple-rinse method will work for them. Moreover, we suggest including lessons about these topics into other training sessions in which most of the farmers tend to attend, in order to speed up the educating process.

Furthermore, since the pesticide manufacturers have already sent trainers to train the retailers/kiosks on the best practice of using pesticides at each retail store, they can also include the lessons about triple-rinse and puncture when educating the retailers and kiosks, and insist them to teach the farmers as well.

Key farmers as a mentor

Since one key farmer has around twenty sub-farmers who obey and are under his supervision, we can gain some advantage from this. We can use the key farmers as a mentor: to teach and guide the sub-farmers about the proper ways to handle and return empty pesticide containers. Consequently, there will be more farmers who follow the good practice of the management program.

3. There should be a tracking system to record and check for pesticide containers.

According to Appendix H, we suggest that a barcode system should be applied to track the pesticide containers. The pesticide manufacturing companies can be the ones responsible for the cost of the barcode system. Moreover, they should monitor the system as well, such as by recording and checking the number of pesticide containers to make sure that all containers reach the waste management companies. As a result, they can prevent counterfeit products and save the reputation of their companies.

4. Incentives should be applied to encourage the participation of relevant stakeholders; retailers, kiosks, and farmers.

There should be some incentives to encourage the participation of retailers, kiosks, and farmers in the management program to attend a training session and return the empty pesticide containers.

Certificates

Certificates can be one of the incentives to give out to farmers, retailers, and kiosk who attend training sessions.

Free Seeds

Free seeds can be given out to the farmers who attend a training session and returning the empty pesticide containers at the retail stores.

Discount Coupons

A discount coupon for pesticides can be a perfect incentive for the stakeholders to return the empty containers. This coupon will be given out to each retailer by the pesticide manufacturing companies. The retailers will give out a coupon when kiosks and farmers have returned the empty pesticide containers to their store. Likewise, retailers will receive a discount coupon when handing over all containers to the transporters. However, the discount coupon must be adequate to compete with the amount that farmers will receive from selling un-punctured containers to the first middlemen and collectors.

Deposit-Return System

The pesticide manufacturers can come up with a deposit fee for pesticide containers. A deposit-return system is a collection system for used pesticide containers' packaging, in which farmers pay a small deposit on every pesticide container. This is refunded when the farmers returned the empty containers that already triple-rinsed and punctured to the retail or kiosk stores where they bought them. However, there is a limitation in this system that the retail price would be a bit higher. In addition, the companies need to ensure that the refund is adequate for the farmers as in the discount coupon.

Areas for Future Research

Based on our results, we suggest that further research and interviews will be necessary for implementing a management program for empty plastic pesticide containers in Karawang and Indonesia.

a. Determine the cost-benefit of the management program

A cost analysis will be another important aspect that must be determined to receive the highest benefits. We recommend setting up a team to carry out an in-depth analysis on the cost-benefit of the complete process of the containers management program: from the pesticide manufacturers who have to create a barcode system to the cost that waste management companies have to pay when collecting the empty pesticide containers from retailers.

b. Increase the sampling number of farmers

We recommend increasing the sampling number of farmers and retargeting the interviewees to be more random with more variety. We suggest interviewing more of the sub-farmers since they are the larger number of the population, meaning that there will be more diverse and other different kinds of behavior that may not emerge from key farmers' interview answers.

c. Expand the baseline study into other cultivation areas

The current project is the only baseline study in Karawang Regency. We recommend expanding the project site into other cultivation areas of Indonesia in order to gather more information about stakeholders. Since in other areas, the stakeholders may have different behaviors which can affect the result of the management program.

d. Research on performance of "Triple-rinse" method

We recommend that CropLife Indonesia hire a professional team to research and conduct an experiment on the performance of "Triple-rinse" method. Although this method has been accepted worldwide, the Indonesian government might need a more solid scientific proof, in order to approve the triple-rinse method for Indonesia itself.

Deliverables

1. Summary of data

The report contains analyzed data on the behavior of three stakeholders (retailers/kiosks, farmers, and collectors), possible waste management methods, and the recommendations which provide useful information for CropLife Indonesia to negotiate with the government and all relevant stakeholders in the future.

2. A Management Program

We had designed a management program that can track back all of the empty pesticide containers as well as can make sure that the containers will be delivered to the co-processing or recycling companies. The management program includes the new value chain of pesticide containers in Karawang, a barcode system, and recommendations in order to ensure the success of the program.

References

1. CropLife Indonesia. (2001). Retrieved from http://www.croplifeindonesia.org/
2. CropLife International. Roadmap for establishing a container management program for collection and disposal of empty pesticide containers. *CropLife International.* **2015**, 1-28 https://croplife.org/wp-content/uploads/2015/10/Roadmap-for-establishing-a-container-management-program_final_Sept.pdf
3. Wikipedia. (2019, Jan 22). Karawang Regency. Retrieved from https://en.wikipedia.org/wiki/Karawang_Regency
4. Badan Pusat Statistik Kabupaten Karawang.(2019). Planted area im Karawang. Retrieved from https://karawangkab.bps.go.id/dynamictable/2018/01/10/14/luas-lahan-sawah-menurut-kecamatan-dan-jenis-pengairan-di-kabupaten-karawang-hektar-2014-2016.html
5. Wikipedia. (2019, Jan 22). Kabupaten Karawang. Retrieved from https://id.wikipedia.org/wiki/Kabupaten_Karawang
6. Ariyono, A.; Nurmalina, R.; Harmini, H. Analisis Pendapatan USAhatani Padi dan Sistem Pemasaran Beras di Kabupaten Karawang, Provinsi Jawa Barat. **2013** https://www.neliti.com/publications/40161/analisis-pendapatan-usahatani-padi-dan-sistem-pemasaran-beras-di-kabupaten-karaw
7. Santoso, R. P. Countering Counterfeiting in Indonesia. *AmCham Indonesia*. **2016** https://www.amcham.or.id/manufacturing-industry/5287-countering-counterfeiting-in-indonesia
8. The GTZ-Holcim Public Private Partnership. Guidelines on co-processing Waste Materials in Cement Production. **2006,** 1-135. https://www.geocycle.com/sites/geocycle/files/atoms/files/co-processing_supporting_document_giz-holcim_guidelines.pdf
9. Pesticide Environmental Stewardship. (2019). Rinsing Instructions. Retrieved from https://pesticidestewardship.org/handling-pesticide-containers/rinsing-instructions/
10. Food and Agriculture Organization of the United Nations; World Health Organization. International Code of Conduct on the Distribution and Use of Pesticides Guidelines on Management Options for Empty Pesticide Containers. **2008**, 1-46 http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/Code/Containers08.pdf

11. United States Environmental Protection Agency. (2006, Aug). Pesticide Container and Containment Regulations At A Glance. Retrieved from https://www.epa.gov/pesticide-worker-safety/pesticide-container-and-containment-regulations-glance
12. Department for Environment, Food & Rural Affairs. (2006). Disposing of pesticide waste. Retrieved from http://www.hse.gov.uk/pesticides/resources/C/Code_of_Practice_for_using_Plant_Protection_Products_-_Section_5.pdf
13. CropLife International. (2017). Guidance Documents on Container Management. Retrieved from https://croplife-r9qnrxt3qxgjra4.netdna-ssl.com/wp-content/uploads/2016/01/Guidance-Documents_allinone_final-oct-2017.pdf
14. FAO; UNEP; WHO. Disposal of bulk quantities of obsolete pesticides in developing countries. **1996**, 1-49. http://www.fao.org/fileadmin/user_upload/obsolete_pesticides/docs/w1604e.pdf
15. Geocycle. (2019). Co-processing. Retrieved from https://www.geocycle.com/co-processing
16. The Environmental Literacy Council. (2015). Landfill. Retrieved from https://enviroliteracy.org/environment-society/waste-management/landfills/
17. Safeopedia. (2019). Sanitary landfill. Retrieved from https://www.safeopedia.com/definition/2963/sanitary-landfills
18. Davao Today. (2017). Leaking of sanitary landfill in Davao city, Philippines.Retrieved from http://davaotoday.com/main/environment/leaking-landfill-waste-imperils-davao-residents-rivers/
19. Pro, L. Overview of Chemical Regulations in Taiwan.*ChemSafetyPro*. **2015** https://www.chemsafetypro.com/Topics/Taiwan/Overview_of_Chemical_Regulations_in_Taiwan.html
20. CropLife International. Brazil leads world in container management. *CropLife International.* **2002** https://croplife.org/case-study/brazil-leads-world-in-container-management/
21. CropLife International. Roadmap for establishing a container management program for collection and disposal of empty pesticide containers. **2015**, 1-28. https://croplife.org/wp-content/uploads/2015/10/Roadmap-for-establishing-a-container-management-program_final_Sept.pdf
22. Toanab, P. V.; Sebesvaria, Z.;Bläsingc, M.; Rosendahlc, I.; Renaud, F. G. Pesticide management and their residues in sediments and surface and drinking water in the Mekong Delta, Vietnam. *Sci Total Environ*. **2013**, *452-453*, 28-39 https://ac.els-cdn.com/S0048969713001897/1-s2.0-

S0048969713001897-main.pdf?_tid=f6143037-8469-41d9-9ccc-f26814c416e7&acdnat=1546678722_e0235c82644e541cc9410ad7f4150451

23. Holcim. (2019). Corporate Profile. Retrieved from https://www.holcim.co.id/en/about-us/corporate-profile
24. PT. Prasadha Pamunah Limbah Industri (PPLI). Company Profile. **2017**, 1-15 http://www.ppli.co.id/assets/Uploads/compro.pdf

Appendices

Appendix A: Definition

In this report, the management program is defined as the program that is used for managing all activities related to Empty Plastic Pesticide Containers which include delivering, selling, collecting, transporting, recovering, and disposing of empty pesticide containers.

The term “recovery and disposal methods” and “waste management methods” are all used interchangeably throughout the text. Our team uses these terms as the representation of reuse, recycling, co-processing, and landfill methods.

The term “counterfeit product” is defined as a fake pesticide product that is made illegally by counterfeit companies. The fake product could be made by diluting the authentic pesticide solution with water or other substances and then refilling into the original containers.

Key farmer is the head of the farmers who owns cultivated land and has several sub-farmers under his supervision working for him.

The first middlemen are the ones who either exchange or buy empty pesticide containers from the farmers and sell those containers to the collectors. For the exchange, they usually give soap, cooking oil, and glasses in exchange for containers.

For the term “second middlemen”, they are the ones who trade between collectors and unknown companies.

Appendix B: Regulations

- Regulation from the Ministry of Agriculture
    - The PDF file can be downloaded at http://perundangan.pertanian.go.id/admin/file/Permentan%2039-2015%20Pendaftaran%20Pestisida.pdf
- Regulation PP101 from the Ministry of Environment and Forestry
    - The PDF file can be downloaded at https://environmentalchemistry.files.wordpress.com/2017/09/permenlhk-no-55-tahun-2015-tata-cara-uji-karakteristik-limbah-bahan-berbahaya-dan-beracun.pdf
- "B3 Wastes" regulation
    - Classification of Hazardous Substances
        - "Regulation regarding hazardous and toxic waste management" Government Regulation Number 19 of 1994, the president of the Republic of Indonesia. The PDF file can be download at http://www.vertic.org/media/National%20Legislation/Indonesia/ID_Regulation_Waste_19_1994.pdf
- Regulation from the Ministry of Industry
    - The PDF file can be downloaded at http://sipuu.setkab.go.id/PUUdoc/175565/PP%20Nomor%2029%20Tahun%202018.pdf

Appendix C: Triple-rinse

Triple-rinse means rinsing the container three times.

Direction[9]

Firstly, empty as much as possible of the remaining contents into the application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Secondly, fill 1/4 of the container with water and recap. Swirl the liquid within the container to rinse the inside surface. Thirdly, remove the cap then pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 30 seconds after the flow begins to drip. Repeat this procedure two more times. Lastly, puncture or crush the container to prevent reuse.

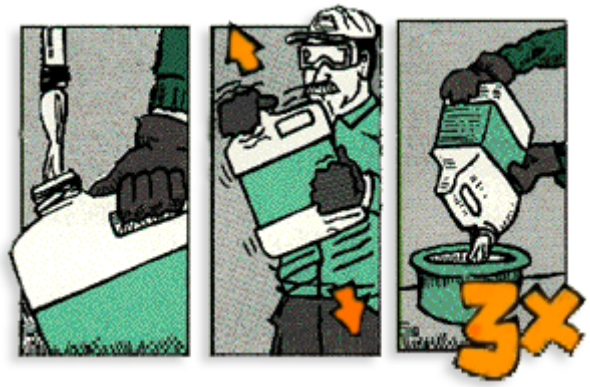

Figure 7: *Triple-rinse process*

Performance of triple-rinse technique[10]

Tests have been undertaken to demonstrate the effectiveness of the triple-rinse method. Table 1 below shows the result of an experiment to determine the quantity of an active ingredient remaining in a container at each of the stages in triple rinsing. From the analysis, it is clearly seen that in each time of rinsing the residue reduces 10 to 100 times.

Table 2: *Rinsing statistics*[10]

Active ingredient in 1 oz (28g) of liquid remaining in a 5-gallon (22.5L) container		
Rinsing stage	**Pesticide residue**	**Percentage remaining**
After draining	14.2 g	100.0%
After 1st rinse	0.2 g	1.4 %
After 2nd rinse	0.003 g	0.021 %
After 3rd rinse	0.00005 g	0.00035%

Appendix D: Successful empty pesticide management programs

Table 3: *Information on empty pesticide containers management programs in some countries*

Countries	Characteristic(s) of the management program
Korea	- Triple-rinse method is approved by the government - Classify empty pesticide containers as non-hazardous waste - Mandatory program - Has private waste collectors who collect, separate, and recycle or incinerate the empty containers
Malaysia	- Triple-rinse method is approved by the government - After triple-rinse, the empty pesticide containers are classified as non-hazardous waste - Mandatory program issued by the government: establishing the Recycling of Used HDPE Pesticide Containers Program. - CropLife Malaysia developed interactive teaching materials for use in schools and work closely with the Ministry of Agriculture
Brazil	- Triple-rinse method is approved by the government - After triple-rinse, the empty pesticide containers are classified as non-hazardous waste - Mandatory management program issued by the government: states that all farmers are required to use the triple-rinse method - Recycle the empty pesticide containers
Australia	- Triple-rinse method is verified by the government - After triple-rinse, the empty pesticide containers are classified as non-hazardous waste - Mandatory management program issued by the government under the Department of Health. (Industry-government co-regulation) - Recycle the empty pesticide containers

Taiwan	- Triple-rinse method is verified by the government - After triple-rinse, the empty pesticide containers are classified as household waste - Mandatory program issued by the government under the Toxic Chemical Substance Control Act. - Recycle the empty pesticide containers

Link for Information

1. **Korea**

   Food and Agriculture Organization of the United Nations. Implementation, Monitoring and Observance International Code of Conduct on the Distribution and Use of Pesticides. **2005.** http://www.fao.org/docrep/008/af340e/af340e0i.htm

   Korea Environment Corporation. (2017). Retrieved from https://www.keco.or.kr/en/core/resource_agricultural/contentsid/1976/index.do

2. **Malaysia**

   CropLife International. (2019). Recycling benefits from container management. Retrieved from https://croplife.org/case-study/recycling-benefits-from-container-management-missing-graphs-and-map/

   CropLife International. IPM Responsible Use Case Studies. *CropLife International*. **1998**, 1-48 https://croplife-r9qnrxt3qxgjra4.netdna-ssl.com/wp-content/uploads/pdf_files/IPM-Responsible-Use-Case-Studies.pdf

3. **Brazil**

   CropLife International. Roadmap for establishing a container management program for collection and disposal of empty pesticide containers. **2015**, 1-28. https://croplife.org/wp-content/uploads/2015/10/Roadmap-for-establishing-a-container-management-program_final_Sept.pdf

   CropLife International. Brazil leads world in container management. *CropLife International.* **2002** https://croplife.org/case-study/brazil-leads-world-in-container-management/

4. **Australia**

   Drummuster. (2019). Classification and Recycling process. Retrieved from http://www.drummuster.org.au/container-recycling/drummuster-standard/

   The Department of Health. (2010, Nov). 11 Disposal of unused pesticide and empty pesticide containers. Retrieved from http://www.health.gov.au/internet/publications/publishing.nsf/Content/ohp-

enhealth-manual-atsi-cnt-l~ohp-enhealth-manual-atsi-cnt-l-ch5~ohp-enhealth-manual-atsi-cnt-l-ch5.11

5. **Taiwan**

   Pro, L. Overview of Chemical Regulations in Taiwan.*ChemSafetyPro*. **2015** https://www.chemsafetypro.com/Topics/Taiwan/Overview_of_Chemical_Regulations_in_Taiwan.html

Appendix E: Interview questions

Interview questions for local Indonesia retailers/kiosks, farmers, and collectors

Procedure of interview process.

1. The interviewees were approached with the assistance of the CropLife Indonesia team and State University of Jakarta students.
2. **Locations:** Three villages; Cilamaya, Wadas, and Jatisari in Karawang Regency, West Java province, Indonesia.
3. Date and time: 22-23 January 2019. 9 am. - 6 pm.
4. Interviewees were individually interviewed.
5. Interviews were **informal**. They were open-ended conversations.
6. UNJ student representatives introduced the team to the local retailers/kiosks, farmers, and collectors in Karawang.
7. Before the interview started, the UNJ students explained the purpose of our visit, the goal of the project, and asked for consent. We also asked for permission to take pictures and record the interview conversations.

Team Roles

- **BSAC students:** developed the interview questions in English before going to the field interviews. Before the interview started, we asked for permission to record the conversation using voice recorder.
- **UNJ students:** translated the interview questions into Bahasa, the official Indonesian language, conducted the interviews in Bahasa and helped translate the answers into English.

Appendix E-1: Interview questions for retailers/kiosks

Interview Questions

Name of a retailer…… **Location……**

Nama toko……..... ***Lokasi…….....***

Name of the owner ……

Nama Pemilik……..

Age: ( ) 10-15 years old ( ) 16-25 years old ( ) 26-35 years old
( ) 36-50 years old ( ) Older than 50 years old

Umur: *( ) 10-15 years tahun ( ) 16-25 years tahun ( ) 26-35 tahun*
( ) 36-50 tahun ( ) Elder than 50 years old/lebih dari 50 tahun

Gender: ( ) Male ( ) Female

Jenis kelamin: *( ) Laki-laki ( ) Perempuan*

Basic information

Informasi Dasar

1. For how long have you been selling pesticides?
   Sudah berapa lama menjual pestisida?
   ( ) Less than 1 year ( ) 1-3 years ( ) More than 3 years
   ( ) Kurang dari 1 tahun ( ) 1-3 Tahun ( ) Lebih dari 3 tahun.
2. Where do you get pesticides from? Please name the company and brand that you sell.
   Dimana anda mendapat pestisida? Nama Perusahaan dan merk yang anda jual?
   a. Which brand or product is the best-selling one?
   Merk Mana yang terlaris?
   b. What are the containers made of?
   Terbuat dari apa wadahnya?
   i. Plastic: HDPE, PET, CoEx
   Plastik: HDPE, PET, CoEx
   ii. Glass
   Kaca
   c. The size/sizes of the containers that you usually sell
   Ukuran berapa wadah plastik yang biasa dijual?
3. How many containers of pesticide can you sell each day/month?
   Berapa banyak wadah yang berhasil terjual dalam sehari/minggu/bulan?
4. Do you realize that there are counterfeit products?
   Apa anda menyadari bahwa ada produk yang palsu?
   a. No/ *Tidak*

b. Yes/ *Iya*
    i. If yes, what are the differences between the fake and the original?
    Jika iya, apa perbedaan antara yang palsu dan yang asli?
    ii. What is the price difference?
    Berapa perbedaan harga antara yang asli dan yang palsu?

Retailer knowledge on pesticide management
Pengetahuan pengecer tentang pengelolaan pestisida

1. Do you receive any training before selling pesticides?
   Apakah mengalami proses pelatihan sebelum menjual pestisida?
    a. No/ Tidak
    b. Yes/ Iya
        i. If yes, where do you receive the training?
        Jika iya, dimana anda mendapatkan pelatihan?
        ii. Did you attend the training partially or fully? Why?
        Apakah pelatihanya sebagian atau penuh?
        iii. What information or skills did you gain?
        Informasi atau keahlian apa yang bisa dipelajari?
        iv. Do you apply all the skills that you have learned from the trainers?
        Apakah keahlianya dapat diaplikasikan?
        v. Do you find the training useful? Why?
        Apakah keahlian itu berharga? kenapa?
2. Do you tell the customers how to handle with the empty pesticide containers?
   Apakah anda memberi tahu bagaimana cara menangani wadah pestisida yang kosong?
    a. No/ Tidak
    b. Yes/ Iya
        i. If yes, what did you tell them? And do they follow your instructions?
        Jika iya, apa yang anda beri tahu pada konsumen? dan apakah mereka mengikuti arahan anda?
3. What do you do with expired pesticides?
   Apa yang anda lakukan dengan pestisida yang kadaluarsa?
4. Do you collect back the empty pesticide containers?
   Apakah Anda mengumpulkan wadah pestisida kosong kembali?
    a. Do you receive the containers for free or do you need to pay for them?

Apakah Anda menerima wadah secara gratis atau Anda harus membayarnya?

b. What do you do with the empty containers?
Apa yang kamu lakukan dengan mereka?

Appendix E-2: Interview questions for farmers

Interview Questions

Name of the farmer …….

Nama Petani ……..

Number of people in the family

Jumlah Keluarga

Adults (over 15):	Male….....	Female….....
Dewasa (over 15):	*Laki-laki….....	*Perempuan….....
Elders (over 60):	Male….....	Female….....
Lanjut Usia (over 60):	*Laki-laki….....	*Perempuan….....

Questions

Pertanyaan

1. How long have you been using the pesticides?
   Sudah berapa lama anda menggunakan pestisida?
   ( ) less than 5 years ( ) 5-10 years ( ) More than ten years
   ( ) kurang dari 5 tahun ( ) 5-10 tahun ( ) Lebih dari 10 tahun

2. How do you use the pesticides?
   Bagaimana anda menggunakan pestisida?
   ( ) According on the label instruction ( ) Farmers experience
   ( ) Retailers' advice
   ( ) Other:_____
   ( ) Mengikuti instruksi pada label ( ) Pengalaman ( ) Penjual
   ( ) Lainnya:_____
3. How do you apply the pesticides?
   Bagaimana anda mengaplikasikan pestisida?
   ( ) Spraying ( ) Other methods
   ( ) Menyemprot ( ) Cara lain
   a. If by other methods, can you explain how?
      ika cara lain, bagaimana anda mengaplikasikannya?
4. Do you wear the full, some or none of the protective equipment (PPE)?
   Apakah kamu menggunakan perlengkapan keamanan (PPE)?
   ( ) Full protection ( ) Some protection ( ) None
   ( ) Lengkap ( ) Sebagian ( ) Tidak menggunakan
5. How many containers do you dispose of each month?
   Berapa botol pestisida yang anda gunakan perbulan?

6. Where do you buy the pesticides?
   Di mana anda membeli pestisida?
   ( ) For retailers ( ) For kiosk ( ) For online store
   ( ) For others
   ( ) Agen ( ) Warung ( ) Toko online
   ( ) Lainnya
   a. If retailers, can you name the retailer?
      Jika dari agen, apa nama agen tersebut?
   b. If others, please clarify?
      Jika lainnya, sebutkan?
7. What brand do you usually use?
   Merk apa yang biasanya anda gunakan?
   a. Can you distinguish between a counterfeit and authentic product based on your experience?
      Berdasarkan pengalaman anda dapatkah anda membedakan barang yang asli dan palsu?
   b. Have you come across a counterfeit product?
      Pernahkah anda mendapatkan produk yang palsu?
      i. If yes, how did you deal with it?
         Jika iya, apa yang anda lakukan terhadap produk tersebut
8. Where do you keep the pesticides?
   Di mana anda menyimpan botol pestisida bekas?
   ( ) In a special storehouse ( ) No where specific
   ( ) Gudang ( ) Di mana saja

9. Do you mix the pesticides before use?
   Apakah anda mencampurkan pestisida sebelum digunakan?
   ( ) Yes ( ) No
   ( ) Ya ( ) Tidak

   a. If yes, why? And how do you know how to mix them?
      Jika iya, mengapa? Bagaimana anda mencampurnya?

10. After using the pesticides, what is your next step?
    Setelah mengaplikasikan pestisida, apa yang anda lakukan?
    ( ) Wash your hands with water
    ( ) Mencuci tangan dengan air
    ( ) Wash your hands with soap and water
    ( ) Mencuci tangan dengan air dan sabun
    ( ) Others…….

( ) Lainnya……..

11. Do you know that pesticides are harmful to human health and the environment?
    Apakah anda mengetahui bahwa pestisida berbahaya untuk kesehatan dan lingkungan?
    ( ) Yes ( ) No
    ( ) Ya ( ) Tidak
12. Do you have any unusual health symptoms after using pesticide?
    Apakah anda pernah mengalami gangguan kesehatan setelah menggunakan pestisida?
13. Do you perform the "Triple-rinse" before you dispose of the empty pesticide containers?
    Apakah anda melakukan "Triple Rinse" sebelum membuang botol pestisida bekas?
    a. How do you perform this? Can you explain the process?
       Bagaimana anda melakukannya, bisa anda jelaskan?
14. What do you do with the empty pesticide containers?
    Apa yang anda lakukan dengan botol pestisida bekas?
    a. How do you dispose of the empty pesticide containers?
       Bagaimana anda membuang botol pestisida bekas?
       i. Do you dump the containers directly into the landfill, water, trash or do you reuse them?
          Apakah dibuang langsung ke tanah, sungai, tempat sampah atau anda gunakan untuk hal lain?
          - If you reuse, in what way?
            Jika digunakan kembali, bagaimana anda menggunakannya?

       ii. Do you prefer to sell the empty containers or hand them over for free?
          Apakah anda lebih memilih menjual botol bekas atau memberikan secara gratis?
          - How much do you get from selling one empty pesticide container?
            Berapa yang anda dapatkan untuk satu botol bekas?
          - Do you know where the empty pesticide containers go after you sell them?
            Apakah anda mengetahui kemana alur pembuangan botol tersebut?

15. How do you dispose of the leftover pesticide solution?
    Bagaimana anda membuang sisa cairan pestisida?
16. Have you attended any training session that has been arranged for you?
    Apakah anda pernah menghadiri pelatihan mengenai pengelolaan botol pestisida?
    ( ) Yes ( ) No
    ( ) Ya ( ) Tidak
    a. If yes, can you explain what kind of training sessions you attended?
       Jika iya, dapatkah anda jelaskan tentang pelatihan tersebut?
       i. Where do you receive the training?
          Di mana anda mendapatkan pelatihan tersebut?
       ii. Do you attend the training partially or fully? Why?
          Apakah anda menghadiri pelatihannya secara penuh atau sebagian? Mengapa?
       iii. What information or skills did you gain?
          Informasi atau kemampuan apa yang anda pelajari?
       iv. Do you apply all the skills that you have learned from the trainers?
          Apakah anda menerapkan ilmu tersebut?
       v. Do you find them useful? Why?
          Apakah pelatihan tersebut bermanfaat bagi anda? Mengapa?
17. In your opinion, what can be other effective ways for reducing the empty pesticide containers? Any suggestions?
    Menurut pendapat anda, bagaimana cara yang efektif untuk mengurangi limbah botol pestisida? Apakah ada saran cara lain?

Appendix E-3: Interview questions for collectors

Interview Questions

Name of the collector……. Location……
Nama Pengepul……... Lokasi……
Name of the owner/ company ……...
Nama pemilik / perusahaan …….....

Basic Information
Informasi Dasar

1. Why did you become a collector?
   Mengapa anda menjadi seorang pengepul wadah bekas pestisida
   a. Is it your main occupation or your part-time job?
      Apakah itu sebagai usaha sampingan untuk mendapat tambahan pemasukan atau sebagai usaha utama?
   b. How long have you been collecting pesticide containers?
      Sudah berapa lama anda menjadi seorang pengepul?
2. From where do you collect the empty pesticide containers?
   Dimana tempat anda mendapatkan wadah bekas pestisida?
   a. From whom?
      Dari siapa?
      i. Do the farmers/retailers bring the empty pesticide containers to you, or do you go directly go to their homes and ask for empty containers?
      Apakah petani atau pengepul lain mendatangi anda untuk memberi wadah pestisida bekas, atau anda mendatangi petani untuk mendapatkan wadah pestisida bekas?
      ii. Are there any middlemen between you and the farmers/retailers?
      Apakah ada pihak lain yang memberi tahu antara anda dengan petani atau pengepul lain?
   b. Do you have to pay for the empty containers?
      Haruskah anda membayar wadah pestisida bekas itu? Atau mendapatkannya secara gratis?
      i. How much do you pay for one unit of container?
      Berapa harga 1 wadah? Wadah apa yang anda gunakan?

ii. Is there a price difference between containers in good condition and damaged ones? (good condition - label, cap, bottle)
Apakah harganya sama antara wadah yang masih bagus dengan yang sudah rusak?(Wadah yang masih bagus – label, penutup wadah, wadah/botol)

iii. Who sets the price?
Siapa yang mematok harga?

3. How often do you collect the empty containers?
Seberapa sering anda mengumpulkan wadah pestisida bekas?
   a. How many containers do you collect?
   Berapa banyak wadah pestisida bekas yang anda dapatkan?
4. What do you do after you have collected the containers?
Apa yang anda lakukan setelah mengumpulkan wadah pestisida bekas?
( ) Clean them
( ) Membersihkan
If you clean them, what technique do you use?
Jika dibersihkan, teknik apa yang anda gunakan?
( ) Sell to a company
( ) Menjual kepada perusahaan/ penguasaha lain
If selling, which company is it? And what will they do with the containers?
Jika dijual, perusahaan apa? Dan apa yang mereka akan lakukan dengan wadah pestisida bekas?
( ) Burn
( ) Membakar
( ) Bury
( ) Mengubur
( ) Cut or resize the containers
( ) Memotong
( ) Others:_____
( ) lain-lain :_____
   a. Please give the reason(s) why you choose the above method(s)
   Apa alasan anda melakukan itu? Dan mengapa memilih metode itu?
5. How often do you sell the empty containers?
Seberapa sering anda menjual wadah pestisida bekas?
   a. How many containers have you sold?
   Berapa banyak wadah pestisida bekas yang anda jual?
6. Do you need any license to collect empty pesticide containers?
Berapa banyak wadah pestisida bekas yang anda jual?

7. What is the range/area of your transportation?
   Transportasi apa yang digunakan?
   a. Transportation cost
      Ongkos transportasi
   b. Transportation mode
      Mode transportasi

Awareness towards pesticide containers
Kesadaran terhadap wadah pestisida

1. Do you wear any protection equipment (PPE) when collecting the empty pesticide containers?
   Apakah anda menggunakan alat pelindung saat mengumpulkan wadah pestisida bekas?
2. How do you differentiate between non-hazardous and hazardous containers? Any indicative signs?
   Bagaimana cara anda membedakan antara wadah pestisida yang tidak berbahaya dengan yang berbahaya? Adakah petunjuk untuk mengindikasi apakah itu berbahaya atau tidak?

Appendix F: Data analysis

Appendix F-1: Findings from retailers and kiosks

Basic information	
Working experience	
Less than 1 year (0)	0%
1-3 years (0)	0%
More than 3 years (5)	100%
Source of pesticide	
Syngenta (1)	20%
Bayer (1)	20%
Corteva (1)	20%
PT. Sanitas (4)	80%
Other retailers (4)	80%
Other companies (5)	100%
The best-selling brand	
Syngenta (4)	80%
Bayer (4)	80%
Agricon (1)	20%
Excel (2)	40%
Other companies (3)	60%
Materials used to make the containers	
Plastic (5)	100%
Glass (1)	20%
Others (1)	20%
Size of containers	
50-100 mL (4)	80%
250-500 mL (5)	100%
More than 1 L (5)	100%
The number of bottles sold	
Note: All of the retailers and kiosks replied that it depends on the season and they could not tell us the exact number due to confidentiality.	
Realization of counterfeit products	
Yes (5)	100%
No (0)	0%
Note: The retailers and kiosks were able to distinguish between authentic and counterfeit products from the packaging i.e. no seal, and its odor. The counterfeit product was also a little cheaper. One of the retailers (Bu	

Haryono) claimed that she knew about the process for making counterfeit products. The counterfeit company diluted the original product with either water or sand and dirt to make it thicker and look more realistic.

Knowledge about pesticide management

Any training gained before selling pesticide

Yes (5)	100%
No (0)	0%

Note: All of them have fully joined the training program. Four out of five received the training in their store, one received in the farmer meeting. Most of the training programs were hosted by Syngenta. They learned about the new product information and the best practice of using it. However, none of the retailers told the customers how to handle empty pesticide containers.

Appendix F-2: Findings from farmers

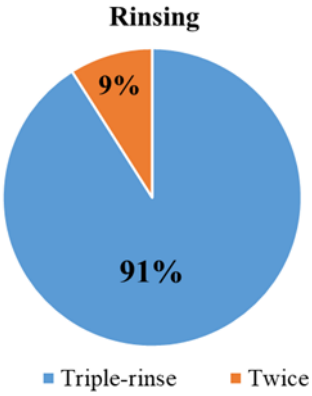

Figure 8: *The number of times that key farmers perform the rinses*

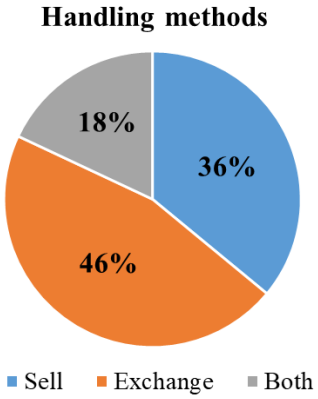

Figure 9: *Empty pesticide containers handling methods*

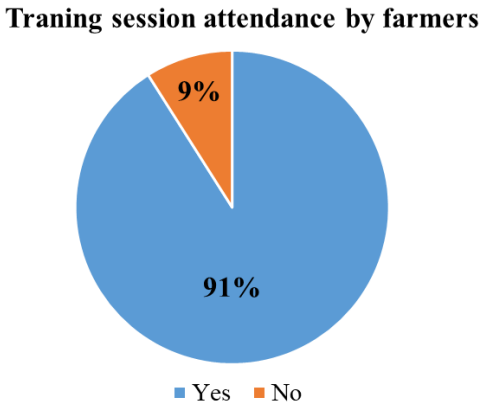

Figure 10: *Training session attendance by farmers*

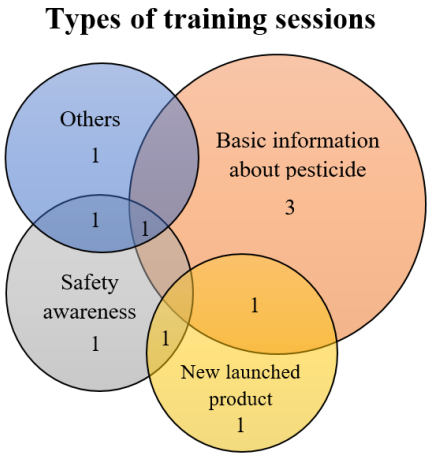

Figure 11: *Types of training session attended by key farmers*

1 key farmer represents 20 farmers under his supervision

11 key farmers were interviewed

The key farmers were selected by CropLife Indonesia based on the ability to speak Bahasa (the native Indonesian language)

The number of years the farmers have been using the pesticides

Less than 5 years (0)	0%
5-10 years (0)	0%
More than ten years (11)	100%

The methods used when applying the pesticide

Spraying (8)	73%
Powder (0)	0%
Both (3)	28%

Personal protection equipment

Some protection (7)	64%
Note: Most farmers use a T-shirt as a mask.	
Full protection (2)	18%
None (2)	18%

Note: Farmers did not wear PPE because it did not feel comfortable while working.

The number of the empty pesticide containers that farmers dispose per month

1-15 empty pesticide containers (2)	18%
16-30 empty pesticide containers (3)	27%

Note: Some of the farmers did not use the correct about the dose of the pesticide.

The place that farmers buy the pesticides

Retailers (6)	55%

Name of the retailers: 2 Sekawan, Tegun Tani, Murni Tani, Putra Cilamaya

Kiosks (5)	45%
Online stores (0)	0%
Others (0)	0%

The brand that farmers usually use

Pexalon (7)	64%
Endure (1)	9%
Both Pexalon and Endure (2)	18%
Agricon (1)	9%

a. Ability to distinguishing between an authentic and counterfeit product

Most farmers can distinguish between a counterfeit and authentic product by smelling, looking at the concentration of the solution, applying the pesticide then seeing the result and identifying by the selling methods. Door to door is more likely to be counterfeit.

Note: The products that can possibly be counterfeit products: Prevathon, Plenum, and Spontan.

Some farmers found the counterfeit products from 2008 to 2010.

b. Reaction of the farmers toward the counterfeit product

All farmers have found the counterfeit product and they all returned it to the place where they bought the pesticides.

Note: When farmers returned the counterfeit product to the retailer, they got a refund.

One farmer mentioned that he found a counterfeit product that was sold by the PPL, a government organization. However, when he returned it, he did not get a refund.

How farmers clean themselves

Washing their hands with water (6)	55%
Washing their hands with soap and water (4)	36%
Others (1)	9%

Mixing pesticide

100% of the farmers mixed the pesticide according to the diseases.

Note: One of the key farmers (Pak Carmudi) mentioned that he used his bare hands when mixing the pesticide.

Awareness of the effects of pesticide on human health and the environmental

Yes (11)	100%
No (0)	0%

Symptoms that farmers experience after using pesticide

Most of the farmers who had symptoms did not use PPE and they mixed the pesticide with their bare hands.

Rinsing methods

Farmers who performed triple rinse (10)	91%
Farmers who rinsed the empty containers twice (1)	9%

The method that the framers used when disposing the empty pesticide containers

Rinse the empty containers twice → Puncture the containers → Collect the containers → Sell and exchange the containers (1)	9%
Triple rinse → Puncture the containers → Collect the containers → Exchange for soap, palm oil, and glass (5)	46%
Triple rinse → Puncture the containers → Collect the containers → Sell the containers (4)	36%
Triple rinse → Puncture the containers → Collect the containers → Sell and exchange the containers (1)	9%

Selling price per kilogram

Out of 11 key farmers, 6 farmers sold the empty pesticide containers

Rp 1,000 - Rp 1,500 (5)	83%
Rp 1,600 - Rp 3,000 (0)	0%
Rp 3,000 - Rp 10,00 (1)	17%

The willingness of the farmers to hand over the empty containers.

Most farmers were willing to hand over the empty containers for free, if the original manufacturers directly collected the containers from them.

Note: One key farmer mentioned that the sub-farmers under him sold the empty containers directly to the collectors without puncture to use the money to buy cigarettes.

The good empty containers without punctures can cost about Rp 10,000 per bottle.

Some sub-farmers throw the empty containers directly into the river.

The number of farmers that attend training sessions

Yes (10)	91%
No (1)	9%

a. The type of training session that farmers attended

Safety awareness

- PPE

Basic information about pesticides

- Dose
- Storage

Newly launched products

Others

- Fertilize-making processes
- Treatment of soil
- Sapling nursery

b. The locations that the training sessions took place

- In the field by the organizers.
- At the hotel when it is an official training session. For example, if the farmers attend an official training section then the farmers will receive a certificate.
- At the district hall when the government gives free seeds.
- Most farmers attend the training section mainly because they gain some benefits from that session but information gained from some of the training session was not applied to their daily life such as using Personal Protective Equipment (PPE).

Appendix F-3: Findings from collectors

The number of years the collectors have been collecting the containers	
1-5 years (3)	30%
6-10 years (5)	60%
More than 10 years (1)	10%
Location for collecting empty pesticide containers	
a. From	
Asking from Farmers directly (6)	60%
From the first middlemen (5)	60%
Directly from retailers (1)	10%
From farmers (1)	10%
From retailers (1)	10%
From collectors (1)	10%
**The first middleman is the person who trades empty pesticide containers between farmers and collectors.*	
b. Compensation for the empty containers	
Cash (4)	50%
Cash and Exchange (2)	20%
Cash and none (2)	20%
None (1)	10%
Price of empty pesticide containers	
Less than Rp 1000 per kg (1)	10%
Rp 1000 per kg (2)	20%
Rp 1500 per kg (1)	10%
Rp 2000 per kg (3)	30%
Rp 3000 per kg (2)	20%
Rp 3500 per kg (1)	10%
a. Difference in price between good and bad condition	
No (9)	100%
Yes (0)	0%
b. Price controller	
Collector him/herself (5)	60%
Head of collectors (2)	20%
Market price* (1)	10%
Depending on agreement (1)	10%
**The market price is set by agreement among collectors*	
Frequency of collecting the containers	
Every day (8)	90%

Once a week (1)	10%
Amount of empty plastic containers that is traded per day	
(0.5 % is the amount of empty pesticide containers from all the plastic)	
10-49 kg (2)	20%
(0.05-0.245 kg is empty pesticide container)	
50-100 kg (3)	30%
(0.25-0.5 kg is empty pesticide container)	
20-30 empty pesticide containers (2)	20%
Seasonal (2)	20%
Usual practice of collectors toward the containers	
Sell to other companies (8)	90%
Give to the head of the collector (1)	10%
Usual practice of people who sell to other company	
Separate according to the kind of material (3)	40%
Separate and burn (1)	10%
Separate and clean (1)	10%
Press and twist (1)	10%
Separate, clean and cut/ resize the containers (1)	10%
Sell to other companies (1)	10%
Bury (0)	0%
How often the containers are sold	
Once a week (5)	60%
Every day (3)	30%
Depends on the second middleman* (1)	10%
**The second middleman is the man who trades between collectors and the waste company.*	
Amount of containers being sold	
10-49 kg/ day (4)	50%
50-100 kg/ day (3)	30%
Seasonal (2)	20%
Transportation cost per day	
Lower than Rp 200,000 (3)	30%
Rp 200,000-300,000 (5)	60%
None (1)	10%
Transportation mode	
Car (3)	30%
Motorcycle with cart (3)	30%
Motorcycle (1)	10%
Both car and motorcycle (1)	10%

Cart (1)	10%
Use of protection equipment (PPE)	
None (6)	70%
Half PPE (mask and gloves) (3)	30%
Full PPE (0)	0%
Way to differentiate between non-hazardous and hazardous contianers	
Odor (5)	60 %
Read at the label (2)	20 %
Smell and read the label (1)	10 %
Believe that every container is non-hazardous (1)	10 %
License for collecting empty pesticide containers	
Have (6)	70 %
Does not have (3)	30 %
Note: A business license from sub-district or head of the village costs Rp 400,000/ 3 years. Collectors can extend the license after 3 years. In addition, they need to pay a scale tax for checking the accuracy of the balance which costs Rp 150,000/ year.	

Appendix G: Equations for calculating the amount of empty plastic pesticide containers

Appendix G-1: Equations for calculating the amount of empty plastic pesticide containers disposed of by farmers.

The ratio for mixing concentrated pesticide is

Pesticide : Water

2 mL: 1 L

One spray tank requires 15 mL of concentrated pesticide solution

$$2 \times 15 = 30\ mL\ of\ concentrated\ pesticide\ per\ spray\ tank$$

One hectare requires ten spray tanks per one time

$$\frac{10\ spray\ tank}{1\ hectare} \times \frac{30\ mL}{1\ spray\ tank} \times \frac{1}{1\ time} = 300\ mL\ per\ hectare\ per\ time$$

Farmers usually use a 100 mL HDPE bottle

$$\frac{300\ mL}{1\ hectare} \times \frac{1}{100\ mL \times 1\ bottle} = 3\ bottles\ per\ hectare\ per\ time$$

Farmers usually spray 6 times per month

$$\frac{3\ bottles}{1\ hectare \times 1\ time} \times \frac{6\ times}{1\ month} = 18\ bottles\ per\ hectare\ per\ month$$

One 100 mL HDPE bottle weighs 17.5 g

$$\frac{18\ bottles}{1\ hectare \times 1\ month} \times \frac{17.5\ grams}{1\ bottle} = 315\ grams\ per\ hectare\ per\ month$$

Rice planting area in Karawang is 95,902 hectares

$$\frac{315\ grams}{1\ hectare \times 1\ month} \times 95{,}902\ hectares \times \frac{1\ kg}{1000\ grams}$$
$$= 30{,}209.13\ kg\ per\ month$$

Therefore, the amount of empty plastic pesticide containers disposed by farmers is 30.2 tonnes/month.

Appendix G-2: Equations for calculating the amount of empty plastic pesticide containers collected by collectors.

According to the interview, one collector can collect around 50-100 kilograms of empty containers per day.

Approximately 0.5% are the empty plastic pesticide containers

$$\frac{0.5}{100} \times 50\ kg = 0.25\ kg\ per\ day$$

$$\frac{0.5}{100} \times 100\ kg = 0.50\ kg\ per\ day$$

Hence, one collector can collect around 0.25-0.50 kilogram of empty plastic pesticide containers per day.

9 collectors is equal to 1% of the collectors in Karawang

$$\frac{0.25\ kg}{1\ day} \times \frac{100}{1} \times \frac{30\ days}{1\ month} = 750\ kg\ per\ month$$

$$\frac{0.25\ kg}{1\ day} \times \frac{100}{1} \times \frac{30\ days}{1\ month} = 1500\ kg\ per\ month$$

Thus, the total amount of empty plastic pesticide containers from every collector in the Karawang area is 750-1500 kg per month or 0.75-1.50 tonnes/month.

Appendix H: A Management Program of Empty Plastic Pesticide Containers for Karawang Regency

For our empty pesticide containers management program in Karawang, we suggested using the barcode system.

The Selling Process (orange arrows)

(1) All the pesticide manufacturing companies should have a barcode on the label of each pesticide container.

(2) The dealers have to scan the barcode before delivering to each retailer, so the companies will know the location of their pesticide containers.

(3) Every time that the retailers sell pesticide containers to kiosks and farmers, they must scan the barcode. In the same manner, when kiosks buy the containers from retailers and sell to the farmers, they must scan the barcode.

The Returning Process (blue arrows)

(4) The farmers must return the empty pesticide containers to the original store from where they purchased them. If the farmers return to a kiosk, that kiosk must scan the barcode and return the containers to the retailer again.

(5) The retailers then scan the barcode to notify the pesticide manufacturing companies that all containers have already been collected.

(6) When the transporters come and pick up the containers, they must scan the barcode once again to notify the pesticide manufacturers and waste management companies about how many containers they have received and will deliver.

(7) After the transporters drop the containers at the co-processing or recycling companies, the companies will scan the barcode to make sure that all containers have been delivered to prevent disappearance of pesticide containers during transportation.

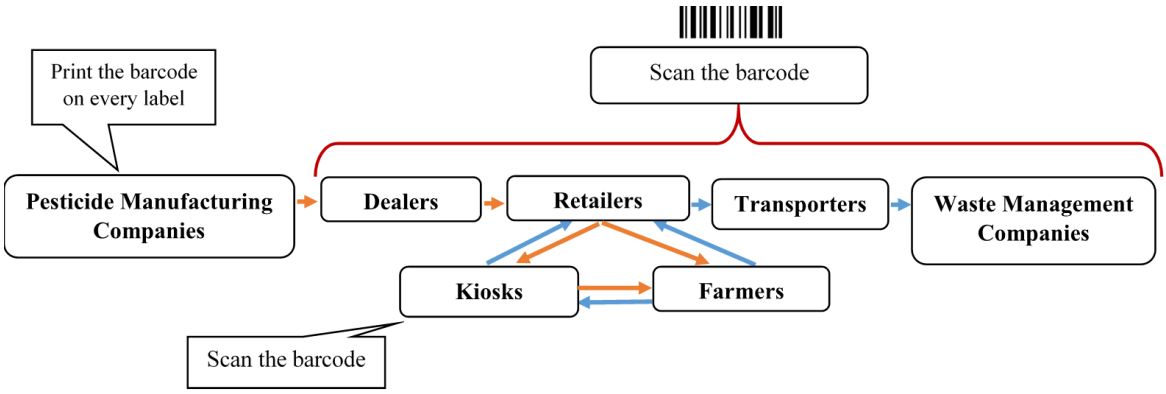

Figure 12: Expected flow of empty plastic pesticide containers in Karawang Regency