

## **ANALYSIS OF THE VOLUMES OF PLASTICS WASTES GENERATED ON FARMS**

### *Summary*

*The volumes of wastes produced at selected farms and the manner of their management are subject to analysis in this study. The wastes from plastics have been divided into four basic groups depending on their type. The volumes and the assortment of wastes from plastics formed at the time of agrarian production in the period of 3 years have been analysed. On the basis of the performed studies, the volumes of wastes from plastics produced at a farm amounts to 57,4 kg·ha<sup>-1</sup> of a farm's area. In the analysed period no statistically important changes in the volumes of wastes from plastics were observed at the examined farms.*

**Key words:** farm, wastes from plastics, recycling enterprises

## **ANALIZA ILOŚCI ODPADÓW Z TWORZYW SZTUCZNYCH POWSTAJĄCYCH PRZY PRODUKCJI ROLNICZEJ NA PRZYKŁADZIE WYBRANYCH GOSPODARSTW ROLNICZYCH**

### *Streszczenie*

*Analizie poddano ilości odpadów wytwarzanych w wybranych gospodarstwach rolniczych oraz sposób ich zagospodarowania. Odpady z tworzyw sztucznych podzielono na cztery podstawowe grupy w zależności od ich rodzaju. Analizowano ilość oraz asortyment odpadów z tworzyw sztucznych powstających podczas produkcji rolniczej w okresie trzech lat. Na podstawie zrealizowanych badań zidentyfikowano ilości odpadów z tworzyw sztucznych wytwarzanych w gospodarstwach rolniczych, co jak obliczono wynosi średnio 57,4 kg·ha<sup>-1</sup> powierzchni gospodarstwa i w badanym okresie nie stwierdzono zmian istotnych statystycznie.*

**Słowa kluczowe:** gospodarstwo rolne, odpady z tworzyw sztucznych, przedsiębiorstwa recyklingowe

### **1. Introduction**

The agrarian production is a dynamically developing branch of economy generating food products. As a result of modernization of the existing and established new farms, there is taking place a process of formation of modern farms generating food products. The agrarian activity covers many activities related to food generation [13]. Within the space of the last several years we have been observing significant changes in the structure of farms and the manner of their functioning [12]. Employment on farms decreases what is compensated with works' mechanization and automation. The drop of the agrarian land is noticeable at the increase in average area of a farm due to the fact of land's designation for road and construction infrastructure's development.

Together with development of the technological advancement, in agriculture, there has been increasing the interest in plastics and their use. Products from plastics are most often used for storage of plant pesticides, fertilizers, packaging of volumetric materials such as fodder for animals and silos' lining.

It results in forming of big volumes of wastes which have to be managed in a correct manner or else they shall constitute a risk for the environment. Wastes of plastics have the values of life cycle assessment (LCA) similar to those of glass [14]. However, it's worth stressing that their collection and storage at the territory of a farm is problematic, what may have an unfavorable impact on the volume of plastics to be recycled, and in case of their pollution with organic residue, may unfavorably impact their further processing [7].

Particularly purposeful is their processing and re-using [8]. Financial support from the Union funds depends on observance of ecological rules of wastes' management.

Wastes which are collected from farms, are cleaned and segregated into specific types, and then they are recycled. Plastics from wastes can be reprocessed, however they are characterized by lower susceptibility to natural factors, and consequently their use is limited [2]. However, in case of correct management more than 90% of wastes of plastics is possible [4]. There are many possibilities of the recycling process's realization, from re-processing through recovery of components (mainly gaseous ones) till energetic recycling. The selection of the recycling manner depends on economical and logistic factors and also the possibilities of utilization [9].

Identification of the volume of wastes aims at assessment of possibilities of their use optimization and the improvement of the manner of their management.

### **2. Purpose of the studies**

The purpose of the studies was to determine the level of generated volume of specific types of plastic wastes in selected farms and the relation to a farm's size.

### **3. Methodology of the studies**

On the basis of data obtained from a recycling enterprise dealing with plastic waste collection from farms, the analysis of the volume of plastic waste generated in farms was conducted. Wastes are collected by recycling enterprises where they are segregated and formed on pellets. Waste prepared like that is then transferred to enterprises dealing with its further processing.

The analysed farms are located in the territory of three provinces. The main branch of farms' activity is plant cultivation connected with breeding of animals. Their area is

differentiated and is in the range of 500-800 hectares (Table 1).

Table 1. Location and area of farms

Tab. 1. Lokalizacja i powierzchnia gospodarstw

Farm	A farm's total area [ha]	Location	
		Province	Powiat
I	800	Pomeranian	Kwidzyn
II	720	Kuyavian-Pomeranian	Grudziądz
III	500	Kuyavian-Pomeranian	Grudziądz
IV	680	Kuyavian-Pomeranian	Grudziądz
V	400	Warmian-Mazurian	Olsztyn

Source: own work / Źródło: opracowanie własne

Plastics, as compared to many other materials, are characterized by very high durability and resistance to environmental conditions' influence [6].

Below there is presented a division of plastic wastes by type of material together with description. The first group includes the polyethylene (PE-HD) of high density, characterized by high mechanical strength and melting temperature 126-135°C [11]. In most cases these are packages of pesticides. Wastes of PE-HD are formed into bales of an average volume mass 414 kg·m<sup>3</sup> (fig. 1).

A)



B)



Source: own work / Źródło: opracowanie własne

Fig. 1. Pesticide packages (A) and silage film (B)

Rys. 1. Opakowania po środkach ochrony roślin (A) i folia kiszonkarska (B)

The second group includes polyethylene films (PE-LD) of low density, transparent, physiologically inert, of high permeability for gases (oxygen, carbon dioxide) [1, 7]. The properties of PE-LD make it possible to store goods from farm production. Most often silage films are the wastes from plastics. They are formed for recycling in bales of the average volume mass of 975 kg·m<sup>3</sup>.

The used bags of BIG-BAG type made of propylene that is hydrocarbonated thermoplastic polymer constitute the next group of plastics [3]. Wastes of PP are formed in bales of average volume mass of 571 kg·m<sup>3</sup>.

Agricultural film also called silo film constitutes the last group. It is made of polyethylene of high density. It is in two colours (white and black) and during the process of fermentation it protects silage against the access of air and light. In some cases its direct re-usage is possible however it must be undamaged that is the condition for the correct ensilaging process [10, 16]. Wastes of agricultural film are formed in bales of the average volume mass of 1463 kg·m<sup>3</sup> (fig. 2).

A)



B)



Source: own work / Źródło: opracowanie własne

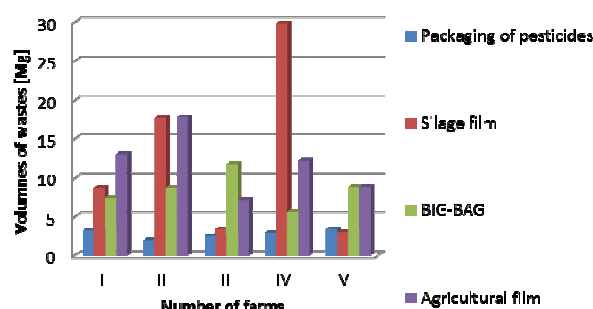
Fig. 2. BIG-BAG (A) and agricultural film (B)

Rys. 2. BIG-BAG (A) i folia rolnicza (B)

#### 4. Results of the studies

The studies were conducted in the years 2013-2015 for five farms of similar scope of activity and differentiated surface's area. The mass of wastes from plastics collected throughout the country in the considered period amounted to 46,3 kg·ha<sup>-1</sup>. The analysed farms in the considered period generated in total 178,1 Mg, what constitutes 2,47% of all the plastic waste generated in Poland in the years 2013-2015 [15] and at the same time it constitutes 0,5% of all the waste generated in the considered period by farms [5].

The obtained results are presented in table 2 and in fig. 3.



Source: own work / Źródło: opracowanie własne

Fig. 3. Volumes of plastic wastes in farms for the years 2013-2015

Rys. 3. Ilości odpadów z tworzyw sztucznych w gospodarstwach rolniczych za lata 2013-2015

In table 3 there is presented a general and shown by individual years volumes of waste of a given type, which was generated in total by concerned farms and per area of a farm's agricultural area.

In figure 4 there is presented a share of individual types of waste with reference to the total mass of all the plastic waste collected in the analyzed period of time.

Table 2. The average volumes of plastic waste generated by farms in the years 2013-2015

Tab. 2. Średnia ilości odpadów z tworzyw sztucznych w gospodarstwach rolniczych powstałych w latach 2013-2015

	Farm I [Mg]	Farm II [Mg]	Farm II [Mg]	Farm IV [Mg]	Farm V [Mg]
Pesticides packaging	1,1	0,66	0,83	0,96	1,13
Silage film	2,9	5,9	1,13	9,93	1,0
BIG-BAG	2,46	2,9	3,9	1,86	2,93
Agricultural film	4,36	5,93	2,4	4,06	2,93

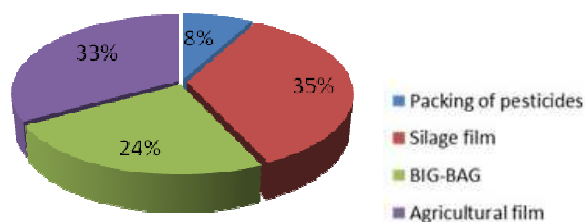
Source: own work / Źródło: opracowanie własne

Table 3. Volume of waste from all the farms by years 2013-2015

Tab. 3. Ilość odpadów ze wszystkich gospodarstw rolnych z podziałem na lata 2013-2015

		Total volume of waste from all the farms [Mg]	The average volume of waste from all the farms for the years 2013-2015 [Mg]	The average volume of plastic waste from all the farms [kg ha <sup>-1</sup> ]	The volume of waste for all the farms for the years 2013-2015 [Mg]
Pesticides packagings	2013	4,6	4,66	1,48	14,0
	2014	4,7		1,52	
	2015	4,7		1,52	
Silage film	2013	20,0	20,86	6,45	62,6
	2014	21,4		6,90	
	2015	21,2		6,84	
BIG-BAG	2013	13,6	14,13	4,38	42,4
	2014	14,1		4,55	
	2015	14,5		4,68	
Agricultural film	2013	19,4	19,7	6,26	59,1
	2014	19,7		6,35	
	2015	20,0		6,45	

Source: own work / Źródło: opracowanie własne



Source: own work / Źródło: opracowanie własne

Fig. 4. The percentage share of individual types of waste for all the farms for the years 2013-2015

Rys. 4. Procentowy udział poszczególnych rodzajów odpadów dla wszystkich gospodarstw za lata 2013-2015

Table 4. Volumes of plastic wastes in individual farms in the years 2013-2015

Tab. 4. Ilości odpadów z tworzyw sztucznych w poszczególnych gospodarstwach w latach 2013-2015

		Farm I [Mg]	Farm II [Mg]	Farm III [Mg]	Farm IV [Mg]	Farm V [Mg]
Pesticides packaging	2013	1,0	0,7	0,9	0,9	1,1
	2014	1,2	0,7	0,8	0,9	1,1
	2015	1,1	0,6	0,8	1,0	1,2
	average	1,10	0,67	0,83	0,93	1,13
Silage film	2013	2,8	5,5	1,0	9,7	1,0
	2014	2,9	6,2	1,2	10,1	1,0
	2015	3,0	6,0	1,2	10,0	1,0
	average	2,9	5,9	1,67	9,93	1,0
BIG-BAG	2013	2,5	2,7	3,6	1,8	3,0
	2014	2,4	3,0	4,1	1,8	2,8
	2015	2,5	3,0	4,0	2,0	3,0
	average	2,46	2,9	3,9	1,87	2,93
Agricultural film	2013	4,3	6,0	2,2	4,0	2,9
	2014	4,3	5,8	2,5	4,2	2,9
	2015	4,5	6,0	2,5	4,0	3,0
	average	4,37	5,93	2,4	4,07	2,93

Source: own work / Źródło: opracowanie własne

The results presented in table 4 present the volumes of plastic wastes which have been transferred by individual farms for their reprocessing. In the analysed farms, the biggest share in the total volume of plastic wastes belongs to the silage film what classifies them respectively on the level of 35% and 33% on a scale of all the wastes generated in the years 2013-2015 by five farms.

The biggest volume of wastes from pesticide packages was generated by farm number I.

In a farm number IV in the period of three years there was generated the highest volume of silage film's waste what, as it has been established during the conducted survey, resulted from a considerable share of animal breeding in the farms' commodity production.

It may be noticed, that the volume of wastes formed from BIG-BAGs is similar throughout all these years for each farm. In the analysed farms BIG-BAGs are mainly used for grain storage and fertilizers are delivered in them.

The volume of wastes from agrarian film formed in farms are classified on the level from 2t in case of farm III to 6t in farm II. The volume of generated waste in specific years by individual farms is similar (Table 5).

Table 5. Volume of plastic waste with reference to a farm's area

Tab. 5. Masa odpadów z tworzyw sztucznych w przeliczeniu na powierzchnię gospodarstwa

	Farm I	Farm II	Farm III	Farm IV	Farm V
[Mg·ha <sup>-1</sup> ]					
Pesticides packagings	1,4	0,9	1,7	1,4	2,8
Silage film	3,6	8,2	3,3	14,6	2,5
BIG-BAG	3,1	4	7,8	2,8	7,3
Agricultural film	5,5	8,2	4,8	5,9	7,3

Source: own work / Źródło: opracowanie własne

## 5. Conclusions

The volume of wastes from plastics for individual farms showed slight changes in individual groups.

No connection between the volumes of wastes at individual farms with the area of a farm was observed. It may be assumed, that it to a bigger degree results from the prevailing type of activity.

No statistically important increase in the volume of wastes from plastics in individual groups in the analyzed period of 2013-2015 was noticed.

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