

Impact of Sachet Water and Plastic Bottle Waste on Agricultural Land in the Ada East District of Ghana

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Authors' contributions

This work was carried out in collaboration between both authors. Authors ADN and KJA designed the study and wrote the protocol. Author ADN wrote the first draft of the manuscript. Authors KJA and ADN reviewed the study design and all drafts of the manuscript. Author ADN managed the data collection of the study. Author ADN performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

The main aim of this research was to create awareness on the negative effects that indiscriminate disposal of sachets and plastic bottle waste have on the agricultural land at Ada East district of Ghana.

The study was conducted in the Ada East district of Ghana., between February 2015 and July 2015.

Simple random sampling techniques were used to sample 50 households out of 350 households in the study area. The study used questionnaires and interviews. Structured questionnaires were prepared to generate primary data from the respondents. Interviews with key informants were additional means used to elicit primary data. Secondary data were also studied, acquired from different reports, published documents from the internet and data from the Department of Agriculture. The collected filled questionnaires were tabulated and analyzed with the help of the

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Statistical Package for Social Sciences. (SPSS). It was observed that 56% of the population were female, and 44% had not received any formal education. The study identified that 54% of the population were farmers. It was further revealed that 76% of the respondents consumed sachet water as it served as the main sources of drinking water in the area. The daily water intake in the area was 1 litre and this was practiced by 56% of the population. It was also revealed that plastic waste generated in the area has little or no alternative uses. The area lacked provisions for waste management; therefore 44% of the respondents littered the plastic waste on the environment. The absence of public education, waste management legislation and organized waste management services in the area contributed to the increased indiscriminate littering of waste on the environment and affected agricultural land, resulting in low productivity in the area. It was recommended that there should be public education on plastic waste management, investment in recycling of plastic waste, and a premium on plastic waste collection and waste bins should be made available for waste collection in public places.

Keywords: Sachet water; bottled water; soil pollution; agricultural land; Ada; Ghana.

1. INTRODUCTION

The emergence of the sachet and bottled water industry in Ghana in the late 1990s has created employment opportunities in most of the rural areas in Ghana, especially the less privileged people who are usually the marginalized and vulnerable ones. It is one of the fastest growing business ventures in Ghana, and those who are into the sachets and the bottled water business have made a lot of profit, acquired properties, sponsored themselves and their families to obtain higher education through the sales and supply of sachets and bottled water. According to the National Association of Sachet and Packaged Water Producers, the water packaging industry created about four million jobs in Ghana in the past five years [1].

Bottled or Sachet water, known colloquially as "pure water" describe water drawn directly from a piped connection of municipally-treated water (or occasionally from a storage tank or borehole), that has gone through an industrial filtration process and sealed in sachets or bottles. The bottled and sachet water came to replace the traditional way of getting access to drinking water in public where the vendor used to scoop water out of a larger storage vessel using plastic or metal cup, to water sold in hand-tied plastic sachets [2]. This indigenous system of selling water to the public was associated with a lot of hygiene issues, as the bags were generally filled with water by women and children under unhygienic conditions which contaminate the water, resulting in adverse health effects, such as cholera outbreak, gastrointestinal illnesses, reproductive problems, and neurological disorders [3]. Sachets and bottled water have become increasingly the sole source of drinking

water at home for most Ghanaian families; even in the most remote villages due to its low price, convenience, ubiquity, and the public perception that sachet water is of higher quality than tap water.

Aside the enormous benefits of the sachet and bottled water business to the economy, it has also become the major source of plastic waste pollution in Ghana. The indiscriminate littering of the sachet and empty bottle waste in various sites such as along the streets, gutters, lorry stations, school compounds, market places, homes, and venues of social functions etc. poses a lot of threat to the environment and agricultural land. The sachets and empty bottles are usually made from non-biodegradable synthetic polyethylene (polythene), which does not decay, they can stay in the soil for more than 100 years. When they are burnt too, they produce oxides of carbon, nitrogen and sulphur which are poisonous to human health and the soil [4]. A study by the European Union revealed that plastic waste contributes to the death of about one million sea birds and 100,000 marine mammals and large number of birds [5]. It is emphasized that plastics are modern conveniences for carrying goods; they are responsible for the environmental and agricultural land degradation that has incidentally used up precious resources of the earth, in particular, petroleum [6]. Excessive plastic accumulation in the soil causes problems such as blocking water penetration into the soil, contamination of ground water, poor soil aeration etc.

Ada has been the marketplace for most of the sachet water producers in the Greater Accra region and the Volta region because of its large local food market that brings people from all over

the country on Tuesdays and Fridays. This has increased sachet and bottled water consumption in the area. The higher consumption of sachet and bottled water in the area is causing a lot of harm to the environment especially agricultural land, due to the nuisance of littering behaviour of the people. Agriculture remains the main source of livelihood in the area therefore any changes in the agricultural land affect their livelihoods which will result in food insecurity and increased poverty. Kunfaa [7] observed that increased in rural poverty can be ascribed to the continuous depletion of natural resources which has resulted in low yields, food insecurity and infertile land. The soil above the plastic layer always remains loose, they are easily carried away in the heavy and seasonal rains creating serious soil conservation problems.

Waste management is an important issue for every country since improper waste management has a lot of negative effects on human health, animals, plants, soils and other organisms. On the contrary, people of Ada seem to care less about the precarious situation. The sachet and bottled water business which was seen as a saviour of the local economic development has become the main source of plastic waste generation and management issue. Increased production and consumption of the sachet and bottled water had led to indiscriminate disposal of empty sachets and plastic bottles leading to serious land degradation in the area. The evidence of this is seen for water sachets and empty bottles littered all over the environment including farms, homes and public places. The volume of plastic waste generated in the area is so alarming, especially on market days. The inability of the local government, individuals and waste management organization to keep up with the task of proper and efficient waste management constitutes the burden of environmental management.

The plastic waste posed threat to crop production, animal rearing, public health and land degradation. This ugly situation has become a major source of concern to agricultural workers since the area is the leading food production in the Greater Accra region. It is against this background that this study is conducted to draw attention of the public to the negative effects of sachets and plastic bottle waste on the agricultural land in the area.

The main objective of the study was to create awareness on the negative effects of

indiscriminate disposal of water sachet and plastic bottle waste and the effects they have on agricultural land.

Specifically;

1. To assess the level of plastic bottle and sachet water consumption;
2. To identify the various ways by which plastic bottles and water sachets are being disposed after usage;
3. To examine the alternative use of water sachet and plastic bottles after drinking their content;
4. To assess the various ways that water sachet and plastic bottle waste affects agricultural land.

The research questions were:

1. What is the consumption level of bottled and sachet water in the study area?
2. What are the various ways by which sachet and water bottle waste disposed in the study area?
3. What are the alternative uses of the sachet and water bottle waste in the study area?
4. To what extent had water sachet and plastic bottle waste affected agricultural land in the study area?

2. MATERIALS AND METHODS

The study was conducted in the Ada East district of Ghana. The Ada East district is conveniently located off the main connecting road between the Ghanaian capital of Accra and the Togolese capital of Lomé. It is bordered on the west by the Dangme West district, on the east and north by Keta district, South Tongu and North Tongu (Volta Region) and on the south by the Gulf of Guinea. In terms of ethnicity the people of Ada are predominantly Dangme who constitute 80% of the population. The District has a total estimated population of 71,671. Females constitute 52.5% of the population and males, 47.5% [8].

The key sectors of the district economy can be analyzed under three broad categories, namely agriculture, industry or manufacturing, trading and services. Agriculture remains the dominant sector and employs about 59% of the labour force, followed by trade and service sector which employs 34.4% whilst manufacturing or industrial sector employs 6.6% of the total labour force in the district. Temperatures are high throughout

the year, ranging from 23 to 33°C, but the sea has a cooling effect. Rainfall is generally heavy during the major seasons between March and September. However, during the harmattan season the area is very dry with no rainfall at all. The district has one of the largest market in the country which brings a large number of traders from all over the country on Tuesdays and Fridays [8].

Table 1. Average annual rainfall data for Ada East district

Year	Rainfall (mm)
2010	315.25
2011	224.50
2012	165.25
2013	158.75
2014	190.25

Source: Ada Meteorological station, Ada MOFA, 2015 [9]

Ada is the leading producer of vegetables and arable crops in the Greater Accra region. Field report (yearly) from the Ministry of Food and Agriculture shows a continuous trend of crop yield decline as a result of land degradation caused by many factors of which plastic waste is a major contributor. The particular area is chosen for the study because it is easily accessible, and heterogeneous in socioeconomic, cultural and geographical structure. Most of the people in this area are engaged in agriculture and livestock farming, which are widely affected by land degradation.

Participants in the study were mainly drawn from the town of Kasseh. Simple random sampling techniques were used to sample 50 households out of 350 households in the study area. This figure was representative of the participants whose contributions reflected the real situation on the ground.

The study used questionnaires and interview. Structured questionnaires were prepared to generate primary data from the respondents. The researchers requested participants to fill the questionnaires to the best of their knowledge and truth. Interview with key informants were additional means used to elicit primary information. Secondary data were also studied, acquired from different reports, published documents from the internet and unpublished data from the Department of Agriculture. The collected filled questionnaires were tabulated and analyzed with the help of the SPSS program for

statistical analysis widely used in research and data analysis through computer.

3. RESULTS AND DISCUSSION

3.1 Gender of Respondents

The majority of the participants selected were females and they constituted 56% of the population whilst males represented 44%. According to the 2010 Population and Housing census, the district had a higher female (52.5%) population than males. The reason for higher female population could be that the area is one of the biggest local markets for foodstuff in the region where thousands of people travel from the length and breadth of the country to trade on Tuesdays and Fridays and women were noted to be involved in trading than men in the Ghana.

Table 2. Gender of respondents

Gender	Frequency	Percentage (%)
Male	22	44
Female	28	56
Total	50	100

Source: field survey, 2015

3.2 Educational Level of Respondents

Table 3 shows that almost half of the population (42%) had no formal education. It also shows that 28% of respondents had basic education, whereas 12% were graduates from the tertiary institutions. Having the majority of the population not having formal education could affect their understanding of plastic waste management and its adverse effects on the soil. This confirms the findings of Pacey [10] that formal education for women in particular is a prerequisite for change in sanitation behaviour.

Table 3. Educational level of respondents

Education	Frequency	Percentage (%)
Basic School	14	28
High/Vocational	9	18
Tertiary	6	12
No formal Education	21	42
Total	50	100

Source: Field survey, 2015

3.3 Occupation of Respondents

Farming and trading remains the major occupation in the area as 54% of the population

are directly engaged in trading and farming. Only 6% of the respondents do other professional jobs such as teaching, banking, carpentry etc. Agriculture therefore remains the main backbone of the economy of the Ada area.

Table 4. Occupation of respondents

Occupation	Frequency	Percentage (%)
Student	5	10
Only farmer	9	18
Only trader	6	12
Farming and trading	27	54
Others	3	6
Total	50	100

Source: Field survey, 2015

3.4 The Household Size of Respondents

The area has a large number of household size as indicated in the Table 5 below, the table shows that 52% of the population are made up of 6-10 members in the household, while 11-15 members per household represented 10% of the population. Most people live in the external family system where uncles, nieces, grandmothers and others stay together with the man's nuclear family. This could account for the large household size in the area. Most farmers in Ghana also practice polygamy system of marriage where the man is allowed to marry more than one wife.

Table 5. The household size of respondents

Household size	Frequency	Percentage (%)
1-5	19	38
6-10	26	52
11-15	5	10
Total	50	100

Source: Field survey, 2015

3.5 Type of Water Used by Respondents

Sachet water is the most consumed water in the area compared to bottled water, Table 6 indicates that 76% of the respondents consumed sachet water; while 18% are those who consumed both bottled and sachet water and 6% consumed only bottled water. The higher consumption of sachet water over the bottled water could be attributed to the price differences, for example the 500 millilitres sachet water cost 0.1 Ghana cedis (\$0.03) while the same 500

millilitres of bottled water cost 1.00 Ghana cedis (\$0.25), the bottled water is ten times the price of the sachet water. Water affordability also depends on the individual's income, those with higher and sustainable income consumed bottled water, whereas those with lower and unsustainable income consumed sachet water since it is cheaper. Sachet water is more available than the bottled water, especially in the rural areas; it is sometimes hard to get bottled water to buy compared to the sachet water which is sold in every area of the country. Attah [11] reported that, many Ghanaians consume sachet water due to the fact that Ghana Water Company Limited (GWCL) is unable to provide treated tap water to the residence of many Ghanaians due to production and distribution limits, continued population growth without urban planning, and non-revenue water losses which weaken the utility to the core. The sachet and bottled water therefore served as alternative drinking water.

Table 6. Type of water used by respondents

Type of water used	Frequency	Percentage (%)
Sachet	38	76
Bottle	3	6
Both	9	18
Total	50	100

Source: Field survey, 2015

3.6 Consumption Level of Sachet and Bottled water by Respondents

Fig. 1, shows the water consumption level per a person in a day. It could be observed that 56% of the respondents consumed 1 litre of water a day, those who consumed 1.5 litres of water a day represent 26% while 4% consumed 2 litres in a day. The respondents revealed that pure water (sachet water) is solely used as drinking water in the households. In terms of cooking and other domestic activities such as washing, bathing among others, they use well water. It was observed that the sachet and bottled water consumed in the area were produced from another district as a result, the quantity of sachet and water bottle waste were determined by the quantity of water consumed by the respondents in the area. It should be noted that 1 litre of sachet water is equal to 2 empty sachets and 1 litre of bottled water is also equal to 2 empty plastic bottles. As shown in Table 4 above, the average household size ranges from 6 to 10 members. It can therefore be deduced that a household of 6 members produces 12 empty

sachets or empty bottles a day. Also a household of 10 members produce 20 empty sachets or empty bottles a day. According to Prochazka [12] about 600 to 800 empty sachets make 1 kg. This shows that a household in the study area produces close to 600 pieces of empty water sachets in a month which is equivalent to 1 kg.

3.7 Means of Disposing Waste Product by Respondents

The Table 7 gives details on how sachet and water bottle waste are disposed in the study area. When asked, 44% of the respondents indicated that they left the plastic waste in the houses, farms and public spaces where they consumed the water. It was also observed that the area lacked provisions for waste management; there were no dustbins at public places and homes for waste gathering. Sule [13] observed that poor environmental conditions in most rural areas can be ascribed to improper management of solid wastes and the lack of seriousness in the enforcement of solid waste disposal code in West Africa. They also revealed that they leave the empty sachets or bottles on the farm after using the water. These left over waste get mixed up with the soil during weeding or ploughing which prevent water penetration into the soil. Wind also blows them to different parts of the farm, some are even seen on the branches of plants which sometimes cause leaf curling and

in small plants they die due to excessive heat stress. During heavy rain they are also carried to a nearby water body which end up contaminating the water. Brinton et al. [14] asserted that there are accounts of inadvertent contamination of soils with small plastic fragments as a consequence of spreading plastic materials on the soil by human, wind, rain water and flood events. According to 28% of the respondents, they bury the plastic waste in the soil. It was observed during the survey that most of the respondents have a pit dug at their backyard where they deposit waste, both plastic and non plastic waste were mixed together and when the pit becomes full they cover it and another is dug. Those who are not able to dig hole dump waste in their backyard. The table also shows that 18% of the respondents gather the sachet and empty bottle waste and burn. Few of the respondents (10%) stated that they don't litter the environment; they carried the waste home for proper disposal. Having only 10% of the population who are conscious of the environment and disposed waste appropriately calls for major concern on plastic waste management in the study area. Abrokwa [15] observed in his research that about 83% of the population dump their refuse in either authorised or unauthorised sites in their neighbourhood, due to ignorance, negligence, weak capacity to handle solid waste and lack of law to punish sanitary offenders.

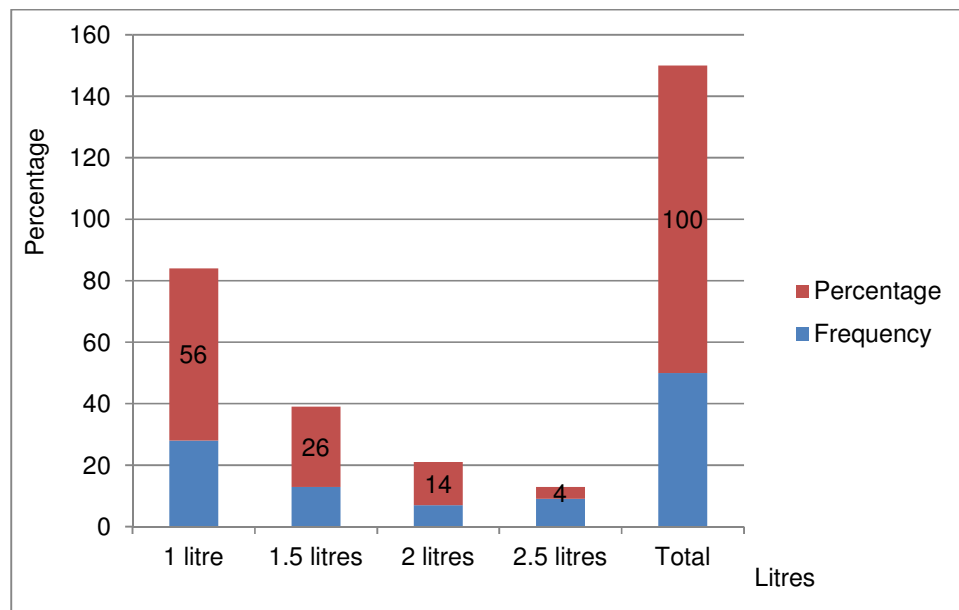


Fig. 1. Consumption level sachet and bottle water by respondents

Source: Field survey, 2015

Table 7. Means of disposing waste product by respondents

Responses	Frequency	Percentage (%)
Bury in the soil	14	28
Left on the farm and public places	22	44
Burn	9	18
Others	5	10
Total	50	100

Source: Field survey, 2015

Table 8. Alternative use of empty sachet and empty plastic bottles by respondents

Response	Frequency	Percentage (%)
Nursing seeds	4	8
Storing liquid products	10	20
Sold	14	28
No use	22	44
Total	50	100

Source: Field survey, 2015

3.8 Alternative Use of Sachets and Empty Plastic Bottles by Respondents

The Table 8 above shows the reuse of empty water sachet and bottle by respondents. It was observed that 28% of the respondents gather the water sachet waste and sell them to trucks that move around to buy. The percentage of respondents who collect the plastic waste are few because of the lack of motivation from buyers, buyers offer them a lower price for more pieces of the plastic sleeves and empty bottles gathered. For instance 600 to 800 pieces of empty sachets make up 1 kg which is bought at a price worth only twelve cents (\$0.12) equivalent to 50 pesewas. It can also be seen in the table that 20% of the respondents use the plastic bottles to store or sell liquid products in the market and shops, some of the liquid products sold are palm oil, vegetable oil, kerosene, pito, ice kenkey (local corn made food) etc. It also indicates that 8% of the respondents use the water sachet as a nursing bag for seeds such as mango, ornamentals, oil palm, orange etc. it can be seen from the table that 44% of the respondent are those who don't use the sachet and empty bottle waste for anything. As these wastes are not put into any use they end up on the environment which subsequently finds its way into the soil or water bodies. Abrokwa [15] observed that low level of technology in waste recycling and management are the major causes

of waste management and environmental problems in Ghana.

3.9 Table 9: Respondents Idea of the Negative Effect of Plastic Materials in the Soil

The respondents were asked about their opinion on the negative effect of water sachet and empty bottle waste on the soil and 58% agreed that they have negative effects on the soil, 20% of them strongly agreed while 22% disagreed. It can be seen from the analysis that majority of respondents are aware of the negative effects that sachet and empty bottle waste have on the agricultural land. They were asked to list some of the negative consequences that these plastic waste have on the soil 73% of them stated that it can cause the soil to lose its fertility while 27% said it prevents seed germination and also kills plants. Abdul et al. [6] stated in their literature that "plastic bags find their ways to agricultural fields and mixed with other decomposed materials; as plastic bags do not decompose with soil they remain in the agricultural lands and blocks as well retard the progress of growth of agricultural plants. Plastic bags have that inherent property that even though very thin, roots of crops fail to pierce them in order to move around the soil for natural nutrients. Thus, plastic bags have caused tremendous harm to the growth of agricultural produces". They further stated that agricultural lands are affected by plastic waste through reduction in soil fertility, decrease in nitrogen fixation, huge loss of nutrients in the soil, decrease in crop harvest, disparity in flora and fauna on soil etc. These negative impacts of plastic bags in fact reduce soil fertility to a great extent and thus reduce agricultural production to a great quantity.

3.10 Annual Crop Yield per Hectare in the Ada East District

The annual yield per hectare of major crops growing in the area shows that yield per 1 hectare of a cultivated land kept on decreasing from 2010 to 2014. In 2010, yield per one hectare of tomatoes was 5.5 metric tonnes, it reduced to 3 M/T in 2012 and a little increase to 4.8 M/T in 2014. Pepper output per hectare reduced from 2.5 M/T in 2010 to 1.9 M/T in 2014. Average per hectare of okro was 4.8 M/T in 2010 it increased to 5 M/T in 2011 and steadily decline to 3.7 M/T in 2014. Watermelon has declined in the last three years from 30 M/T in 2010 to 26 M/T in 2014. This decline in yield has been

attributed to climate change but a critical view of the situation tells that climate change alone is not the main factor. Table 1 shows the continuous reduction in rainfall in the area which affirms the fact that a climatic variation is a major player. It could be observed in Table 1 above that 2013 received the lowest rainfall but in the same year yield increased. Similar trend followed in 2014, rainfall increased by 31.5 millimetres but still yield decreased. This trend shows that other factors played active role in the annual yield reduction in the area of which plastic waste influence on depletion of soil fertility cannot be trivialized. Most of the farms are closer to residences where water sachet and plastic bottle together with other plastic materials cover the land surface due to improper waste disposal, these waste got mixed up with the soil during rainfall and tilling of the land, since plastic can stay in the soil for close to 100 years without decaying it then become an element of destruction to the soil. Atuanya et al. (2012 p. 108) [16] observed in their research that the addition of plastic granules to soil resulted to increase in the total organic carbon content and bulk density of the soil while the total porosity was reduced. They reported that after eight weeks of planting maize in a soil treated with plastic granules the height and the stem girth of the maize reduced significantly as compared to the soil that was not treated with plastic granules. They therefore concluded higher amount of plastic waste in soil causes reduction in water infiltration into the soil, reduced aeration and

poor penetration which adversely affect the soil and crop yield.

Table 9. Respondents idea of the negative effect of plastic materials in the soil

Response	Frequency	Percentage (%)
Strongly agree	10	20
Agree	29	58
Disagree	11	22
Total	50	100

Source: Field survey, 2015

Bhattacharjee et al. [17] asserted that high accumulation of water sachet and plastic materials in soil causes water logging on the upper layer of the soil, which eventually results in reduced aeration and conservation, poor penetration which adversely affect the crop yield. The district director of agriculture in the Ministry of Food and Agriculture confirmed that, "aside climate change, plastic materials are the contributing factors of soil nutrient depletion in the area" (field survey, 2015). The district crop officer also added that "although much attention has been given to climatic variation as the primary cause of low productivity in agriculture recently, but the excessive accumulation of plastic waste in the soil has also been a contributing factor of soil degradation which reflects on low output from agriculture." (Field survey, 2015).

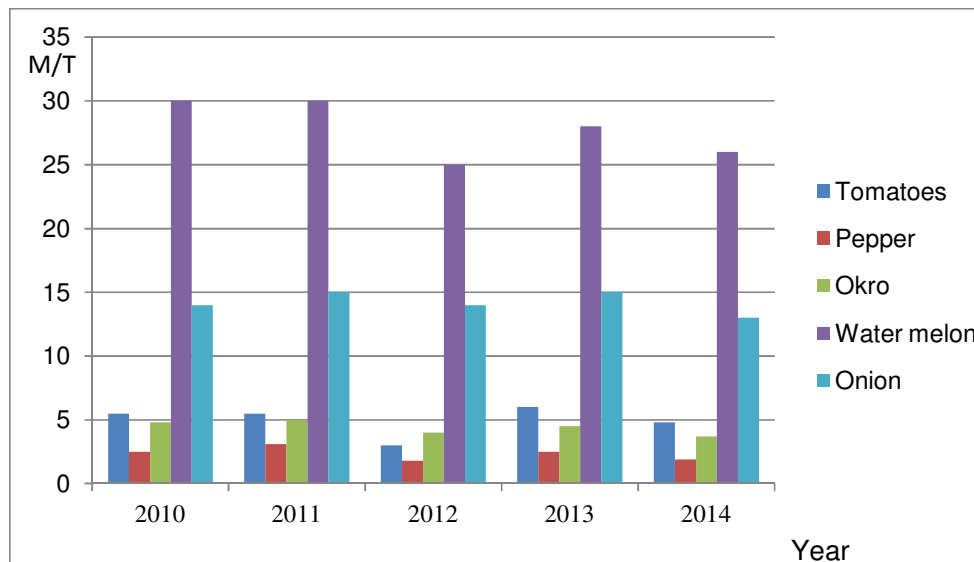


Fig. 2. Annual crop yield per hectare in the Ada East District

Source: Ministry of Food and Agriculture Ada, 2015 [18]

4. CONCLUSION

The study concludes that in the study area, the consumption of sachet and bottled water is really high as it served as the main source of drinking water in the area. The waste produced from the plastic bottles and the sachets on the other hand, has little or no alternative uses; they are therefore littered anyhow on the environment. The majority of the respondents were aware of the negative effects of plastic waste on the agricultural land, but lack of education, organized waste management services and strict waste management rules in the area caused them to litter plastic waste indiscriminately. This practice has contributed to land degradation causing low agricultural productivity annually in the area. Based on the findings of this study, it is recommended that the Local Government together with the Ministry of Food and Agriculture, the Environmental Protection Agency should embark on public education on plastic waste management practices to reduce the littering of plastic materials on the environment. Farmers should also be cautioned on the damages that plastic materials can cause on the soil and the adverse effects on crop yield. The education can be done through radio, television, newspaper or any other social media. Public education should also start from schools; when the children are taught how to dispose plastic waste in the schools they will not litter waste they generate on the environment. They will also be able to educate their colleagues who are not attending school. They will also play key role in educating their parents and neighbours on the negative effects of indiscriminate disposal of plastic waste. The church is one of the biggest social institutions in Ghana; about 75% of Ghanaians are Christians who go to church almost every Saturday and Sunday. The leadership of the various churches should include waste management education in their programmes and sermons. This will create a great avenue for change in the society.

The local government should make available waste bins in the public places to enable people to drop in waste after drinking water or using plastic materials. There should be individuals who are in charge of waste collection in the community to empty the bins on a regular basis to avoid over full of the dustbins. Landlords should provide dust bin in the homes to enable the tenants to drop in their waste. Plastic waste should not be mixed with general waste. Farmers should gather all the sachets or bottles and bring

them to the house for proper disposal to avoid soil degradation.

The government should liaise with private companies and water producers to establish a recycling plant at the district or a nearby area to enable the waste generated to be recycled. The plastic waste on the environment will reduce by reusing the plastic bottles again. Tap water can be filled into the empty bottles and keep in a fridge which can be used as drinking water for the household. By doing this we will not only reduce plastic pollution, but also save money.

The government should introduce a law that ensures that people don't litter waste anyhow on the environment; there should be more sanitary inspectors to ensure that the law is obeyed, those who violate it should be given a fine that will serve as a deterrent to other. Also the government should ensure that, before any company starts producing sachet water, they have made provision for reusing or recycling machine which will be part of the policies and criteria for issuing license to sachet water producers.

The local government should support and encourage the collection of plastic waste in the district by increasing the amount paid to the collectors, this will make it attractive for people to gather plastic waste and sell. This will help reduce the littering of plastic waste on the environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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