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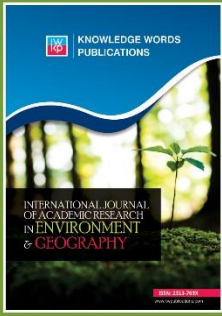
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# INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN ENVIRONMENT & GEOGRAPHY



## Converting Discarded Water Sachets and Other Plastic Wastes into Wealth

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### Abstract

The issue of environmental degradation caused by plastic waste products occupies a central place at both national and international conference, yet little has been done to arrest the problem particularly in developing countries. About ten billion U.S. dollar worth of plastic materials enter the Nigerian market annually. Of this total, about 90% are thrown away after usage as solid waste or useless materials. We have perfected the technologies to refine and convert ethylene into polyethylene and other plastic materials, but we have not made any strides towards recycling used water sachet and other plastic waste products in our environment. This paper is developed on the belief that recycling of plastic waste products is one secret of converting waste into wealth as well as turning poverty into affluence with the aim of turning the entire stakeholders into agents of environmental sanitation in Enugu State. Against this background, this paper examines the sanitary and economic implications of recycling used water sachet and other plastic products in the state. ESWAMA was established by Edict No. 8 of 2004 to put in place the machinery for achieving this objective. Water sachets and plastic products are produced from polythene, a polymer of ethene, a monomer. Plastic waste recycling consists of sorting, collecting and processing the recyclable plastic waste and molding the densified materials into marketable products. Plastic recycling extends the resources life span, reduces energy consumption, reduces investment cost on equipment and provides employment opportunities and therefore reduces poverty. The two main types of recycling – open loop and close loop – which can be adopted in Enugu State include both reuse and recovery. Recycled post consumer plastic products such as park benches, picnic tables and chairs are highly marketable because they are colour fast, non-corrosive, cheap and no-absorbent, and therefore, requires minimal maintenance. Used tries can also be recovered and reused commercially – as supplemental fuel in paper and pulp industry – to generate income. Sorting and scavenging increases both the quantity and rate of capture of the recyclable plastic waste materials. These activities are sub-optimal because of poor recycling facilities and lack of deliberate government policy and legislation on plastic recycling. Consequently, the author commends public education and enlightenment programmes,

establishment of recycling industries, market promotion of the recycled products and deliberate government policy on recycling to arrest the environmental problems created by plastic waste material in Enugu State.

**Keywords:** Plastic Waste, Wealth, Polythene, Recycling, Sorting, Scavengers.

## Introduction

The Longman Dictionary of Contemporary English defines sanitation as “the protection of public health by removing and treating waste, dirty water, etc” People who put measures in place for the promotion of public and environmental health are regarded as agents of environmental sanitation. They control and minimize environmental pollution.

The issue of environmental pollution and degradation caused by solid waste especially plastic waste products occupies a central place at both national and international conferences (PRF, 1991a; 1991b; Nwafor, 2006). Today 5<sup>th</sup> June 2018 Nigeria joins the rest of the world to celebrate this year’s world environment day in a grand style. The theme for this year Beating Plastic Waste in our Environment. It is matter of global concern; yet little seems to have been done in order to control the present rate of generation and growth of mounting heaps of plastic waste products in our city environments to arrest the pressing problems of land degradation and environment pollution with their associated poverty links (Darnay, 1972; Troost and Altman, 1972; Grubb and Co-workers, 1995; DFID, 2005; 2006; Nwafor, 2006).

The situation is worse in developing countries like Nigeria, Ghana and Senegal where plastic waste consists a substantial part (about 69%) of non-biodegradable solid waste in the environmental because it has more cumulative effects on the environmental than biodegradable organic matter. Currently, in Nigeria, plastic materials estimated at a value of about ten billion U. S. Dollars (\$10.0 billion U.S.) enter the market annually. Of this total, about 90%, that is, \$9.0 billion, are usually thrown away after usage as solid waste, discarded or useless material. This illustrates the final aspects of plastic waste handling in Nigeria today. Here in Enugu State, we may ask ourselves why it is that we find uses for the waste plastic materials in the maintenance of leaking old plastic containers, buckets and even leaking house roofs but are unwilling to prevent the squandering and loss of valuable plastic materials after they have been converted into finished goods?

The answers may seem to be that whereas we have perfected the technologies necessary to harvest, separate, refine and convert ethylene into polythene and other plastic materials, no matter how complicated their chemical structure or how heterogeneous the mixtures in which we find them, we have not made any strides towards recycling of used plastic material (such as discarded water sachets and bottles, utensils, buckets and containers, tables, chairs and even automobile tyres) because we have had no opportunity of receiving any enlightenment on the plastic waste recycling aspect of environmental sanitation and its economic implications. This problem justifies the urgent need to centre this stakeholders workshop on the theme, water sachet and plastic materials, producers and users as agents of environmental sanitation” with special reference to the sub theme: ‘Recycling of used water sachet and other plastic products : its sanitary and economic implications.

Our resources of the major raw material (i.e. hydrocarbon reserves) may last for a long time in the future because we are yet to tap the hinterland hydrocarbon deposits. But if the

current rates of industrialization and population growth rates in Nigeria persist, shortages may begin to set in even before the turn of the first quarter of the 21<sup>st</sup> century.

We in Enugu State shall therefore be collaborating efforts towards the recycling, marketing and reuse of plastic waste materials litred everywhere in our environment. The plastic and water sachet industries should therefore now concentrate efforts on creating the technologies, the distribution and financial structures that will give us flexibility in plastic waste recycling in the third millennium. Indeed, recycling of water sachet and other plastic wastes is one of the proven secrets of converting waste into wealth as well as turning poverty into affluence. This is a plastic waste management policy consistent with the needs of the world's civilization today and environmental sustainability.

### **Aim and Objectives**

The aim of this paper is consistent with the reform agenda of Enugu State Government through the State Economic Empowerment Development Strategy (SEEDS). The broad aim here is to commit the entire stakeholders to the issue of a new waste management method designed to recycle plastic waste products such as discarded water sachets, bottles and containers e.t.c. This aim is very laudable in Enugu State as it will help to create a sustainable and healthy environment as well as preventing unwanted loss of very valuable and recyclable waste materials, which can in turn lead to poverty reduction in the state.

To achieve this aim, the specific objectives of the paper are therefore designed to

- (i) Examine the existence and production of polythene/plastic products
- (ii) Assess the utility of plastic waste recycling for commercial purpose.
- (iii) Investigate the role of scavengers in the marketing activities and the economic implications of the recycled plastic waste products.

The machinery required for achieving these objectives in Enugu State has also been put in place by ESWAMA in its new strategic environmental policy.

### **Eswama and the New Strategic Environmental Policy**

Enugu State Waste Management Authority was established by Edict No. 8 of 2004 as a component of the steady march of success in environmental sanitation (Okoh, 2005). Its operation was launched on January 25, 2005 by the then State Governor, His Excellency Dr. Chimaroke Nnamani with pageantry. While backing the position statement on the new environmental policy in Enugu State during the stakeholders' workshop on Strategy and Development for Sustainable Environment, the Governor pointed out that pollution and poor solid waste management have impacted negatively on the State's socio-economic activities and led to an outrage of poverty in the State. He therefore, challenged the stakeholders to show more concern on reduction of poverty in the strategic policies and programmes (especially in areas of plastic waste recycling and reuse) for sustainable environment.

The Enugu State Ministry of Environment and Solid Minerals has also reorganized its activities towards achieving this new strategic waste management policy of turning waste into wealth in the State. It was this new orientation that gave rise to its successful launching of ESWAMA by the Ministry on 25<sup>th</sup> January, 2005 in partnership with the UK Department for International Development. The new authority is currently headed by a Managing Director. DFID (2006) also observed that the private sector, the industrialists and the public in general should

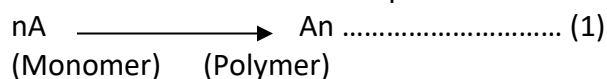
be more productive and involved in addressing environmental pollution arising from plastic solid waste. Further to this, Okoh (2005) emphasized that the recycling of plastic wastes and the active involvement of selected and empowered Private Sector Participants (PSP) on waste management in Enugu State should be fully functional.

This stakeholders' workshop on "Water Sachet and Plastic Materials: Producers and Users Agents of Environmental Sanitation" is therefore targeted at achieving fully this new strategic environmental (waste) management policy in Enugu State. Consequently, it becomes necessary for us to first of all examine the existence as well as production of polythene/plastic/rubber products from which the non-biodegradable plastic wastes in our environment emanate.

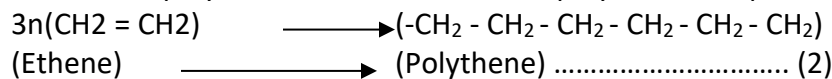
### Existence and Production of Polythene/Plastic Products

Ethylene (or ethane) is the major raw material used in the industrial manufacture of polyethylene (or polythene) and a host of other plastic products. It is a colourless carbon compound, which is gaseous at room temperature and pressure, almost insoluble in water and slightly less dense (vapour density = 14) than air (vapour density = 14.4). its chemical formula is  $C_2H_4$ .

When ethene is pressurized (in the presence of an oxygen trace) to about 100 atmospheres and heated to initiate the action, it is polymerized to produce polythene – a plastic product. Polymerization is the combination of many molecules of the same compound – monomer – to form one complex molecule with no gain or loss of material – polymer thus:



The polymerization of ethane into polythene is represented as:



Where n is about 300. From this process, polythene is similar to a very complex alkane and has common chemical reactivity with this group. Polythene is therefore an addition polymer with only one monomer molecule and only one product popularly called polythene, plastic or rubber (PRF, 1991a, 1991b). polymerization of ethane is exothermic and requires cooling once the reaction has started. The polythene/plastic material produced by this process is a low density material which softens at a temperature of about 393K (120°C). it can be moulded at this temperature to produce a variety of domestic and scientific articles such as balloons, hand gloves, rain coat, condoms, footballs and bladder, pure water sachets, flexible containers, basins, buckets, plates, spoons, canopies, water proof bags, satchets, GSM recharge cards packages, gift items and their packages, water bottles and wash bottles, toys, feeding bottles, file, bags, fruit juice and mineral drink bottles, table mats and covers as well as other products.

If the ethane is subjected to pressure into an inert solvent, containing a Ziegler catalyst – a unique catalyst named after Sir Ziegler, the Industrial Chemist who invented the technique – a high density form of polythene with a softening temperature of 493K (1300C) is formed. This brand of polythene is highly resistant to the common types of chemical action and therefore can be moulded at its softening temperature to make valuable scientific, industrial and domestic plastic and rubber articles in large quantities. These include buckets, floor carpets, tiles and rugs, foot mats, food flasks, funnels, plates, chairs, tables, canopies, automobiles decoration parts,

cables, tyres, tubes, biro pen cases, erasers, boots, shoes and shoe heels, glasses, eye glass frames, lamp holders, rubber bullets etc. (PRF, 1991a; 1991b).

Note that rubber material can be made from the juice of para-rubber trees or artificially from cracking crude petroleum products. When sulphur is used in the vulcanization of rubber, the soft pliable rubber is converted into a hard tough substance from which automobile tyres and similar products are made.

## **Plastic Recycling Types and Economic Importance**

### **Plastic Waste Recycling and its Economic Implications**

Recycling of plastic waste materials as well as other types of solid waste products has been proposed and adopted in many countries of the world particularly in the advanced countries because of its economic advantage (PRF, 1991b). For instance, table 1 shows a comparison of municipal solid waste management by recycling and other conventional disposal methods in 21 industrialized nations. Aquino (1994) has shown that by 1990 at least ten countries – Australia, Canada, Denmark, Finland, France, Japan, Netherlands, Norway, Sweden and USA – have adopted solid waste recycling as a strategic environmental policy for their countries. This is because recycling possesses very many advantages over other conventional treatment technologies (Oldenburg, 1993; Agunwaba, 2001) such as landfill, composting and incineration.

Recycling of plastic waste is the conversion of a hitherto perceived useless (discarded) used plastic material, container or water sachet into an economically valuable material (PRF, 1991a, 1991b).

Fundamentally, it consists of

- (i) Collection of recyclable plastic waste materials
- (ii) Sorting the materials into different classes or generic types.
- (iii) Processing (usually by heating or grinding) into densified form and
- (iv) Moulding and modifying the densified material into different marketable products.

### **The Economic Advantages of Plastic Recycling**

A good system of plastic recycling has very many economic advantages over the methods of waste treatment methods. These, according to Agunwamba (2001) include:

- (i) Extension of the period of existence of the valuable resource, that is elongation of the resource life span, thus preventing economic waste on resources.
- (ii) Reduction of the consumption of energy and associated environmental pollution.
- (iii) Minimization of dependence on imported plastic products thus promoting and encouraging local industries.
- (iv) Reduction of investment cost on equipment, thus increasing the profit margin.
- (v) Minimization of the physical volume of waste materials which otherwise in turn leads to reduction of the associated environmental pollution and degradation.
- (vi) Reduction of undue demand and stress upon land space for landfill site. Thus, this can help to make available more land space for other uses such as residential and industrial purposes.
- (vii) Provision of employment opportunities to the unemployed young graduates and school leavers and so reduces poverty.

(viii) Generation of income/revenue through the sale of recycled products.

The extent of recovery of the different plastic waste materials in Enugu State and their subsequent successful recycling depends upon their recyclability (that is, a measure of the ease with which the plastic materials are recovered and utilized). Recyclability also is a function of the cost effectiveness of the recovery and the unit costs of the recovered plastic waste material as well as its degree of purity.

**Table I: Comparison of Municipal Solid Waste Management by Recycling and other Disposal Methods in 21 Industrialized Countries**

S/N	Country	Year	Total ('000 tons) collected	Percentage of the Quantity Recycled	Percentage by other disposal methods
1	Australia	1990	2,762	16	84
2	Canada	1990	17,636	10	90
3	Denmark	1985	2,678	7	93
4	Finland	1990	3,417	19	81
5	France	1990	22,397	4	96
6	Germany	1990	20,816	0	100
7	Greece	1990	3,307	0	100
8	Hungary	1989	5,401	0	100
9	Ireland	1984	1,212	0	100
10	Italy	1991	22,081	0	100
11	Japan	1990	54,307	3	97
12	Luxemburg	1990	187	0	100
13	Netherlands	1989	8,189	4	96
14	Norway	1990	2,204	12	88
15	Poland	1990	12,115	0	100
16	Portugal	1990	2,797	0	100
17	Spain	1990	13,828	0	100
18	Sweden	1990	3,527	13	87
19	Switzerland	1990	3,307	0	100
20	UK	1990	22,044	0	100
21	USA	1990	195,644	15	85
	<b>Totals</b>	-	<b>431,859</b>	-	-
	<b>Average</b>	-	<b>20,561</b>	<b>8</b>	<b>92</b>

(Sources: Adapted from Aquino, J. T., 1994 and Agunwamba, J. C. 2001)

### **Types of Recycling**

There are two main types of plastic waste recycling which can be adopted in Enugu State. They are:

#### **Close-Loop Recycling**

In this type, the recovered water sachets and other plastic waste materials are refined and returned to their original application. In other words, the plastic waste material is reprocessed and rerouted into the materials main stream. This is the reuse aspect of recycling.

#### **Open Loop Recycling**

This second type of recycling involves no refinement of the recovered plastic waste. The plastic waste materials are directly utilized in degraded applications usually after washing especially in the maintenance of leaking plastic containers and in certain types of work.

Plastic recycling therefore includes both reuse and recovery (Oldnburgy, 1993, Agunwamba, 2001). This is why we in Enugu State should no longer regard used water sachets and other waste plastic materials as unwanted material but rather as a cheap and rich source of raw material which can be reprocessed into highly priced new products on commercial quantities.

### **Recycled Plastic Products and Re-Use**

#### **Recycled Post-Consumer Plastic Products and Re-use**

The raw materials for the recycling of post-consumer plastics packaging come from all the plastic packaging and products discussed in section 4.0 of this paper especially from polythene products such as polyethylene terephthalate (PET) and high density polyethylene (HDPE) which are used in beverage containers. The collected plastic waste materials are first granulated, then melted at very high temperature (usually over 400K), and processed in an extruder. The molten plastic (now almost in a liquid state) is then forced into a mould cavity of the shape and size of the final product such as park benches, picnic tables and chairs, fences, road markers, car stops.

Clean post-consumer and industrial commingled (mixed) plastic materials can be moulded into a variety of new products that command very high prices in the consumer market. The products are highly marketable because of the following advantages.

- (i) They are colour fast and non corrosive
- (ii) They are moisture/ chemical resistant because they are non absorbent
- (iii) They are splinter free and relatively unscratchable or cracking
- (iv) Their substances are relatively physically inextractable
- (v) They are cheap and affordable by the poor.
- (vi) They are largely termite and carpenter ant proof.
- (vii) They require comparatively minimal or no maintenance.

### **Tyre Recycling**

Tyre recycling provides a special problem of solid waste management because stockpiling of discarded tyres in landfill site is unsightly and harbours mosquitoes. Again whole tyres cannot be economically compacted to reduce landfill site capacity. So they can occupy a great height up to the landfill surface and create problems to the final cover.



At present in Enugu State some people like butchers especially those in Artisan market and many other livestock markets and abattoirs in the state burn tyres openly to generate fire/energy which they use in processing the skin (or “Canda”) of the livestock (goats, sheep, rams or cows). Some other group of persons also burn the tyres in order to extract the wires which they use in a special type of basket making. Tyre combustion openly releases poisonous/toxic smoke which is hazardous to human health. Old used and discarded tyres can be recovered and re-used commercially in many ways to generate income:

(i) **Use as Supplemental Fuel in Paper and Pulp Industry:** Tyres can be used for supplemental fuel for boilers in paper and pulp industry which is normally an energy intensive process. The energy content of whole tyres is comparatively very high. For instance, while coal yields between 26,000 and 31, 000KJkg<sup>-1</sup> whole tyres and tyre derived fuel chips yield 30,000- 35,000 KJkg<sup>-1</sup> (Agunwambam, 2001). Therefore, industrialists in paper and pulp production can save huge sums of money by utilizing tyre-derived energy but they should dewier the tyres before using them. This is to ensure that the metal concentration in boiler ash is reduced as well as to eliminate adherence of metals slag to the boiler grate system. The main pollution problem here is caused by gaseous emissions and ash disposal which can be contained within the industrial site.

(ii) **Use as Cement Kiln Fuel:** Tyres and tyre derived chips can also be utilized in supplying fuel in cement kilns. Ground tyre rubber can be mixed with asphalt cement for use as a binder for the mineral aggregate particles in asphalt pavement. Ground tyre rubber can also be utilized in replacing a proportion of the mineral aggregate.

(iii) **Application as Artificial Structure to Minimize Environmental Disaster and Accident**  
Many other uses of whole tyres include applications in artificial reefs and breakwaters to prevent disastrous hydrological event, soil erosion control and express road/highway crash barriers.

### **The Role of Sorting and Scavenging in Successful Recycling and Product Marketing**

#### **Sorting**

Commercial recycling of plastic waste depends on source separation where different waste components are placed in different waste bins or different compartments of a single bin. One bin can be partitioned into three parts. One compartment will receive pure water sachets and other recyclable plastic waste. The second will be devoted to decomposable organic waste matter while the third should be reserved for other non-recyclable materials. Alternatively, one bin can be reserved solely for used water sachets and plastic waste products and a second bin for other wastes. Sorting should be done at the source of generation because it:

- (i) Helps in producing compose lower in heavy and recyclable plastic waste than when the waste is not separated at source.
- (ii) Greatly increases the percentage of recoverable plastic waste materials for recycling when compared with mixed waste products.
- (iii) Increases the rate of capture of the recyclable plastic materials.
- (iv) Requires easier and monetarily inexpensive technology for sorting at source and subsequent processing than when the waste is not source separated.

Commissioned Private Sector Participants (PSP) should also be involved in collecting the recyclable plastic component of the solid waste for sale to industries recycling waste products.

### **The Role of Scavengers**

At present a significant role is played by scavengers in Enugu State in recycling and marketing of the plastic products. Some of the scavengers make routine visits on daily bases to both illegal and legal waste dump sites to search for and collect different types of recyclable used and discarded plastic packaging, sachets, bags and containers. They wash these products and repackage or re-bag them for marketing to industrialists or individuals who need them and make very big profit.

Another group of scavengers especially in the cities like Enugu, Nsukka, Onitsha and Abakiliki go round the streets from house to house asking for and purchasing various forms of not only used plastic sachets, containers and bottles and bags but also beverage cans, waste papers and metals. The scavengers resell these products to the industrialists and individuals who require them at a handsome financial reward.

However, it has been observed by Agunwamba, (1994; 2001) that the roles of the scavengers are sub-optimal as a result of their illiteracy, poor recycling and processing facilities, absence of deliberate federal, state or local government policy on recycling and lack of enabling socio-economic and legal environment.

### **Conclusion**

In this paper, we have examined the existence and production of polythene, water sachet and other plastic products and assessed the utility of plastic waste recycling as well as its economic implications. This is a new environmental strategy which gave rise to the successful launching of ESWAMA on 25<sup>th</sup> January 2005. We discovered that plastic products are produced from polythene – a polymer of ethane (a monomer). These polythene products particularly water sachets and a large variety of other plastic products after usage and discarded end up forming a substantial proportion (sometimes up to 60%) of the solid waste component in our environment because of their cumulative effect and inability to undergo easy bio-degradation. The following conclusions are also made.

These waste products form the major raw material for plastic waste recycling which is a strategy of turning waste into wealth. Recycling of plastic waste has a lot of economic and commercial implications because it reduces investment cost on equipment and over dependence on imported plastic product, provides employment opportunities and so increases the profit margin of the stakeholders involved.

Two recycling methods- Close loop and Open loop can be adopted in Enugu State. Recycled products from such methods such as park benches, picnic tables and chairs are highly marketable because they are colour fast, non corrosive, affordable, less energy demanding and non absorbent. This explains why plastic material recycling has been proposed and successfully adopted in several developed countries.

In Enugu State, scavengers play significant roles in recycling business but unfortunately, their activities are sub-optimal because of poor recycling facilities, illiteracy and lack of deliberate government policy on plastic waste recycling. These findings and conclusions form the basis of the recommendations made in Section 9.0 below.

## **Recommendations**

### **Promotion of Source Sorting Activity**

Those who generate the waste should be encouraged to sort the waste at source in different dustbins or partitioned bin by giving them some financial incentives or a reduction or discount in environmental sanitation rate. This will help in promoting the efficiency of source separation of solid wastes generated in homes, institutions and industries in Enugu State.

### **Public Education and Enlightenment Programmes**

One of the rights enshrined in the consumer charter is the “Right to be informed”. Consumers and stakeholders in plastic products lack sufficient information about the environmental and economic consequences of their choice and use of plastic products. Public education programmes and periodic stakeholders workshop of this nature are therefore strongly recommended to enlighten them on the environmental and commercial implications of recycling post consumers plastic waste products.

### **Establishment of Plastic Recycling Industries**

The stakeholders, the industrialists, the government and private individuals are advised to establish industrial outfits devoted solely to the recycling of plastic waste products and their commercialization. This will help to create job challenges and more employment opportunities with the resultant handsome financial benefits for thousands of unemployed young graduates and school leavers. This will thus help to reduce unemployment and poverty in Enugu State.

### **Deliberate Government Policy and Legislation on Plastic Waste Recycling**

The Enugu State Government in collaboration with the federal is advised to make a deliberate government policy and legislation to effective and successful plastic waste recycling and commercialization of the recycled products

### **Market Promotion of Recycled Products**

The Marketing or commercial department of plastic industries should embark on active promotion of “backward distribution” of recyclable plastic waste materials with financial incentives. This will help in recovering most the plastic component of the solid waste and so prevent their widespread occurrence in the environment. This will also protect the larger society that may not be directly involved in the use of such plastic waste.

### **Minimizing Plastic Waste Collection Cost**

The ESWAMA and the PSPs are constantly grappling limited funding. The author therefore recommends that the PSPs and stakeholders involved should operate the plastic waste collection system in such a way that the total haul cost is minimized. The linear programming method and network analyses are highly recommended here for this purpose so as to maximize the profit margin in selling the recycled plastic products.

### **Product Development**

New product development from the recyclable plastic is also recommended especially to the recycling industries and concerned individuals. The plastic waste products can be collected, washed, ground or melted and moulded into pellets which can now be packaged in small unit

weight measures of say 500 – 1000gm. They can now be sold in this form to the recycling industries to produce the final recycled product. A more deformation resistant plastic products and new plastic packaging and containers which command more attractive prices should also be developed by the recycling industries.

For these recommendations to be successfully achieved, there must be a willing co-operation between the federal and state government, producers and users of water sachet and plastic materials. It is only then that the producers and users of these plastic products can truly pose as agents of environmental sanitation in Enugu State.

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