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What Iraq Can Achieve from Recycling Solid Household Waste

Prof. Dr. Rola Abdel Khader Abbas Al-Safi - Prof. Dr. Abdel Hamid Rahim Mahdi Al-Sarraf

Al-Bayan Center Studies Series

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Al-Bayan Center pursues its vision by conducting independent analysis, as well as proposing workable solutions for complex issues that concern policymakers and academics.

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Since 2014

What Iraq Can Achieve from Recycling Solid Household Waste

Prof. Dr. Rola Abdel Khader Abbas Al-Safi*
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I. Summary:

- The prevalence of informal and unregulated housing systems, coupled with the inability to control waste disposal systems, leads to waste accumulation and the spread of epidemics and diseases, affecting rural areas as well.
- The quantity of waste is expected to multiply approximately 2.6 times in the coming few years and is projected to reach 30.4 million tons by 2050, multiplying about 7.9 times due to various human activities in Iraq.
- Ignoring the recycling of this waste misses the opportunity to obtain huge amounts of paper, plastic, iron, fabrics, and organic fertilizers that could save the country billions of dollars annually spent on importing these products.
- From January 1, 2012, to January 1, 2013, the Iraqi state could have produced 4.844 million tons of organic fertilizer from garbage, which could be successfully used to fertilize a portion of the agricultural land totaling 6.599 million dunams[1], in addition to providing food for 543.77 thousand cattle and buffaloes.
- If these areas were planted with alfalfa, the quantity would increase

1. Dunam. (2024, April 8). Wikipedia. https://en.wikipedia.org/wiki/Dunam#:~:text=In%20Iraq%2C%20the%20dunam%20is%202%2C500%20square%20metres

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to 14.869 million tons, doubling about 2.25 times over 38 years while saving the cost of environmentally and health-harmful chemical fertilizers.

- Iraq could produce 1.868 million tons of paper equivalent in oil value to 747.2 thousand tons, 154.049 thousand tons of glass, 632.768 thousand tons of metals, and 1.898 million tons of plastics. These quantities are expected to reach 5.745 million tons of paper (equivalent to 2.249 million tons in oil value), 1.976 million tons of glass, 1.945 million tons of metals, and 5.836 million tons of plastics by 2050.
- The sorted materials from the garbage in 2012 were sufficient to establish 72 factories for metals, paper, glass, plastics, organic fertilizers, and fabrics equivalent to 80.117 million dollars, while the materials that could be sorted in 2050 are expected to encourage the establishment of 223 factories for metals, paper, glass, plastics, organic fertilizers, and fabrics equivalent to 246.345 million dollars.
- Consequently, these substantial investments naturally create a sustainable source of national income for Iraq. Additionally, recycling operations in Iraq help save the expenses incurred by the Ministry of Health for preventing diseases affecting humans.
- Recycling provides thousands of job opportunities and stimulates income circulation and motivation in organizing the waste sector and its economy.

II. **Introduction**:

Municipal systems in the developing world, particularly in Arab countries, struggle to provide the necessary capabilities for lifting, transporting, and safely disposing of their cities' solid waste. It is known that these countries' efficiency in disposing of city garbage does not

exceed 40%, while 60% is left in the streets, alleyways, or in abandoned or undeveloped spaces between houses. People try to dispose of it through unsafe burning or burying. Exacerbating this disaster is the proliferation of slums around and within major cities, resulting from increasing migration from rural areas to urban centers.

Overall, the magnitude of the problem is not confined to cities; rural areas in most of these countries also lack the facilities to dispose of garbage properly. Naturally, this accumulation of garbage provides the necessary food for the growth of insects and animals that feed on it, leading to serious health risks, particularly for the poor and those living in informal settlements.

Advancements in civilization and industry have made the problem of household solid waste even worse; because modern garbage, which often contains organic materials that decompose quickly, also includes a relatively high proportion of materials with long or indefinite decomposition periods (such as plastic oil bottles, food wrappings made from aluminum foil, cardboard lined with plastic, candles, and plastic bags). These materials, which have found no other disposal methods in rural and random areas around cities, end up being thrown into water bodies, whether drainage channels, canals, or lakes.

III. Research Problem:

Household waste causes serious environmental problems in many countries, including Iraq. Expert companies often fail to accurately identify these wastes, and many service projects have failed due to the lack of precise information about these wastes.

On this basis, it is impossible to formulate a plan or strategy for recycling waste or attempting to recover primary resource sources from it or even reusing it before we know what the wastes are, their quantities, their sources of production, who will pay for their transport

and recycling, and who can benefit from them. This facilitates the establishment of an environmental information bank about the volume of solid household waste in Iraq, and the connection between the user or the one who will benefit or who will recycle it and the producer of this waste, especially since we know well that from the owner's perspective, the waste is considered valueless and the owner usually prefers not to spend on it, even if the purpose is disposal.

IV. Research Hypothesis:

The research hypotheses are summarized in answering the following questions:

- The percentage of the solid household waste generation map for each governorate for the year 2012 in Iraq.
- The amount of garbage produced by the central, southern, and northern governorates in the Iraqi environment from 2012 to 2050.
- The amount of solid household waste in Iraq from 1996 to 2013.
- The quantity of garbage generated in urban and rural areas of Iraq from 1996 to 2013.
- The development in the components of the garbage generated from Iraq from 1996 to 2050.
- The composition of garbage debris in Iraq compared to Greater Cairo and the United States.
- The qualitative composition of the garbage component map (tons/year) in three Iraqi cities, estimates for 2012.
- The economic losses incurred by contemporary generations resulting from the loss of national wealth (garbage).

- The national wealth that can be produced from garbage in Iraq, present and future.
- The economic return expected from recycling organic waste as fertilizer.
- The economic return expected from recycling waste materials (paper and rags).
- The economic return expected from recycling waste materials (glass).
- The economic return expected from recycling waste materials (plastic).
- The savings of water required to produce paper from natural sources by recycling paper from garbage from 1996 to 2002.
- The economic return from selling unsorted plastic waste to retail trade.
- Organic fertilizer by governorates and its relation to the reclamation of agricultural lands and providing food for cows and buffaloes after planting them with alfalfa (2012).

V. **Objective of the Current Study**:

This statistical study aims to provide a database on the quantity and components of solid household waste generated from the governorates of Iraq; to give a true picture of the waste problem in our country over the past seventeen years based on real data from the environmental information bank (which includes everything published in 1995 in the Arab world about waste sources and their quantities). This statistical description should cover the amount of garbage generated in urban and rural areas due to the lack of available statistics on the quantity or

quality of solid household waste for the period between 1996 and 2009 in Iraq.

Furthermore, the current study aims, based on all the classified statistical data at the level of the village, then the city, then the governorate, then the country, to describe the economic losses incurred by contemporary generations resulting from the loss of national wealth garbage and to highlight the importance of this national wealth in the future from 2013 to 2050 by extracting materials or reusing them, such as using them as fuel, extracting metals and organic materials, or soil treatment.

VI. Application of the research:

The database concerning the quantity of solid household waste and its outputs related to the governorates of Iraq for the year 1995 was monitored only from the environmental information bank. Unfortunately, there is no comprehensive record of the presence of this waste in the environment of Iraq's 18 governorates at the Ministry of Public Works and Municipalities or the Baghdad Municipality. After the mid-1990s and over a period of 17 years, which Iraq experienced and was supposed to be taken as a basis for comparison, this inevitably caused a very high-pressure system in the long term on the possibility of success of projects serving the Iraqi environment. This period, which is crucial in discussions about the environment and its problems and ways to protect it, depends fundamentally on recycling these wastes. We were unable to reduce or reuse them in an attempt to recover raw materials due to the lack of a data bank about their volume and quality as previously mentioned. Based on this, the following steps were taken:

Step One: (**How to calculate the population of Iraq from 2012 to 2050**).

Iraq's area is 43,737,000 hectares, and Table (1) shows the population census of Iraq for the years (1977 – 2011) according to the statistics of the Ministry of Planning / Central Statistical Organization for the population in Iraq.

Table (**1**): **Population Census of Iraq for the years between** (**1977 – 2011**).

:(Iraq's Population Data (1977-2011) (in thousands				
Year	Males	Females	Total	Notes
1977	6,183	5,817	12,000	*
1978	6,389	6,016	12,405	
1979	6,603	6,218	12,821	
1980	6,815	6,423	13,238	
1981	7,035	6,634	13,669	
1982	7,260	6,850	14,110	
1983	7,504	7,082	14,586	
1984	7,756	7,321	15,077	
1985	8,015	7,570	15,585	
1986	8,283	7,827	16,110	
1987	8,396	7,939	16,335	*
1988	8,675	8,207	16,882	
1989	8,953	8,475	17,428	
1990	9,190	8,700	17,890	
1991	9,460	8,959	18,419	
1992	9,731	9,218	18,949	
1993	10,001	9,477	19,478	

1994	10,271	9,736	20,007	
1995	10,541	9,995	20,536	
1996	10,843	10,281	21,124	
1997	10,987	11,059	22,046	*
1998	11,328	11,374	22,702	
1999	11,682	11,700	23,382	
2000	12,047	12,039	24,086	
2001	12,424	12,389	24,813	
2002	12,814	12,751	25,565	
2003	13,216	13,124	26,340	
2004	13,629	13,510	27,139	
2005	14,055	13,908	27,963	
2006	14,493	14,317	28,810	
2007	14,943	14,739	29,682	
2008	16,058	15,837	31,895	
2009	15,910	15,754	31,664	**
2010	16,326	16,155	32,481	***
2011	16,758	16,572	33,330	***
According to the results of the general population .censuses, except for Kurdistan on October 16, 1997				*
According to the results of the enumeration and .numbering for the year 2009				**
.The years 2010-2011 represent projections				***

Source: Central Statistical Organization, Annual Statistics for Various Years.

The population of Iraq for the years 2012, 2013, and 2050 has been estimated using the geometric progression formula as follows:

$P_1=P_o(1+ r)^n$ ..... (1)

where:

- P_1 = Population in the target year.
- P_o = Population in the base year.
- r = Expected population growth rate.
- n = Number of years.

Using this method, the estimated population for:

- 2012 is 34,329,900
- 2013 is 35,359,797
- 2050 is 105,557,009

During the period between 1990 and 2013, the population growth rate was stable at around 3% annually, according to the data from the Central Statistical Organization.

Step Two: How to Calculate the Daily Waste Generation Rate per Capita in Iraq from 1996 to 2003.

According to the environmental bank data from 1995, the average waste generated per person in Iraq did not exceed 0.5 kilograms per day, influenced by the economic sanctions that had a significant impact on the Iraqi citizen during the peak period between 1995 and 2003. With the lifting of the economic sanctions in 2003, there was a noticeable change in living and consumption patterns, as well as a sudden influx of goods and products into the society. Observations in this field and studies

from the Solid Waste and Environment Department of the Baghdad Municipality indicate that by 2012, the average solid household waste generated per individual had increased to 0.8 kg per day. This figure reflects the average daily waste production per individual in Iraq, considering Baghdad's dominance over other cities in Iraq, where political and economic activities are concentrated, leading to a higher population density and thus higher waste generation, especially among newcomers who tend to generate more waste daily compared to long-term residents. For comparison, in some affluent regions like the United States and Gulf countries, the average waste generation can reach up to 2.5 kg per person per day.

Given this background, this study adopts an average daily waste generation rate of 0.8 kg per person. To understand and visualize the remarkable development in the quantity of garbage resulting from human activity in Iraq from 2003 to the present, it is essential to apply the following equation:

(2) .... **The daily generation rate for all people of the city or country for the target year in units of tons per year.** × **Average per capita production of garbage in units of kg per capita per day** = **The population of the city or country for the target year.**

Through the data available to us, the process of applying Equation No. (2) will be divided into two parts in terms of the average daily production of garbage per capita and the number of populations in the target year:

A- When the average per capita production of garbage does not exceed (0.5 kg) per capita per day during the period between 1996 and 2002, equation No. (2) will be written in the following form:

The population of Iraq for the target year (1996 - 2002). × **0.5 kg per person per day.** = **The daily excretion rate for all people in Iraq for the target year (1996-2002).**

B- When the average per capita production of garbage does not exceed (0.8 kg) per capita per day in the period between 2003 and 2013.

The population of Iraq for the target year (2003 - 2013).	**×**	**0.8 kg per person per day**	**=**	**The daily excretion rate for all people in Iraq for the target year (2003-2013).**

Accordingly, we obtained Figure No. (1), which represents the amount of household solid waste in Iraq for the period extending from (1996-2013).

Figure (1) Quantity of household solid waste in Iraq in the period from (1996-2013).

Step Three: Estimating the Garbage Generation by Central, Southern, and Northern Governorates from 2012 to 2050

To estimate the population of each governorate for the target years and to calculate the amount of garbage generated, we rely on the data from the census and enumeration of 2009 (Table 2). By applying equation (1), we can project the quantity of garbage produced by each governorate in urban and rural areas through 2050.

Table 2: Population Distribution by Governorate for 2009

Population Distribution by Governorate for 2009			
Governorate	**Urban Population**	**Rural Population**	**Total Population**
Nineveh	1,888,497	1,218,451	3,106,948
Kirkuk	950,140	375,713	1,325,853
Diyala	657,355	713,680	1,371,035
Anbar	718,583	764,776	1,483,359
Baghdad	5,842,318	860,220	6,702,538
Babil	816,036	913,630	1,729,666
Karbala	673,724	339,530	1,013,254
Wasit	666,191	483,888	1,150,079
Salahuddin	591,398	746,388	1,337,786
Najaf	867,940	353,288	1,221,228
Qadisiyah	608,325	469,289	1,077,614
Muthanna	298,779	384,347	683,126
Dhi Qar	1,097,436	646,962	1,744,398
Maysan	668,118	254,772	922,890
Basra	1,923,109	482,325	2,405,434

Total for 15 Governorates	18,267,949	9,007,259	27,275,208
Kurdistan Region Governorates:			
Erbil	1,274,090	257,991	1,532,081
Dohuk	786,599	285,725	1,072,324
Sulaymaniyah	1,515,775	269,078	1,784,853
Total for Kurdistan Region	3,576,464	812,794	4,389,258
Total for All of Iraq	21,844,413	9,820,053	31,664,466

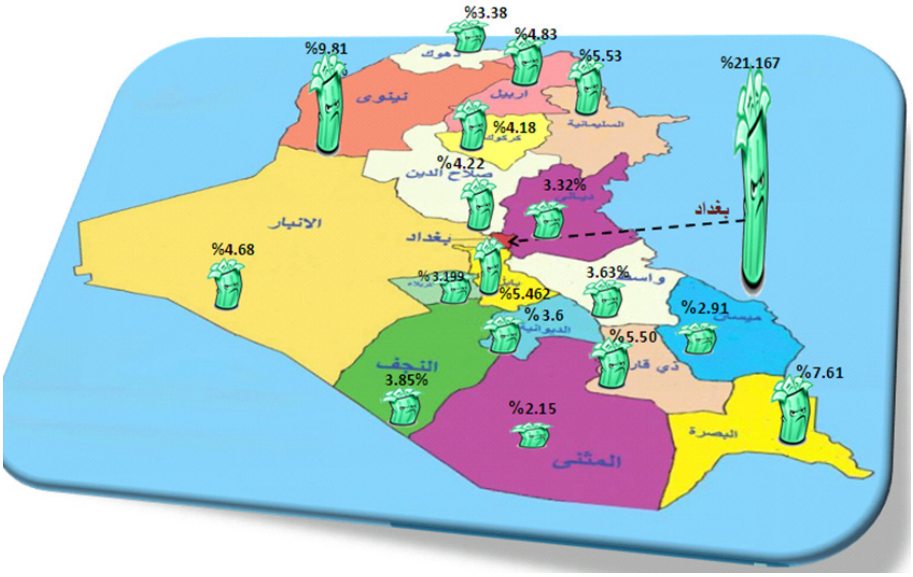


Figure (2) Percentage map of household solid waste generation for each governorate for the year (2012).

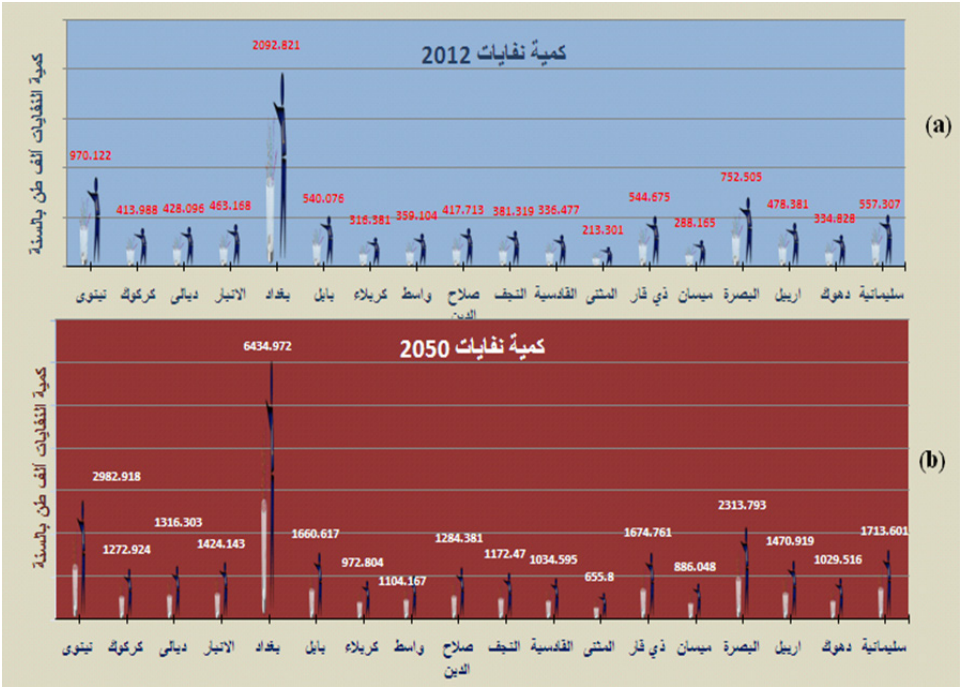


Figure 3- A-B: The amount of garbage collected by the central, southern, and northern governorates in the Iraqi environment in the period from 2012 to 2050.

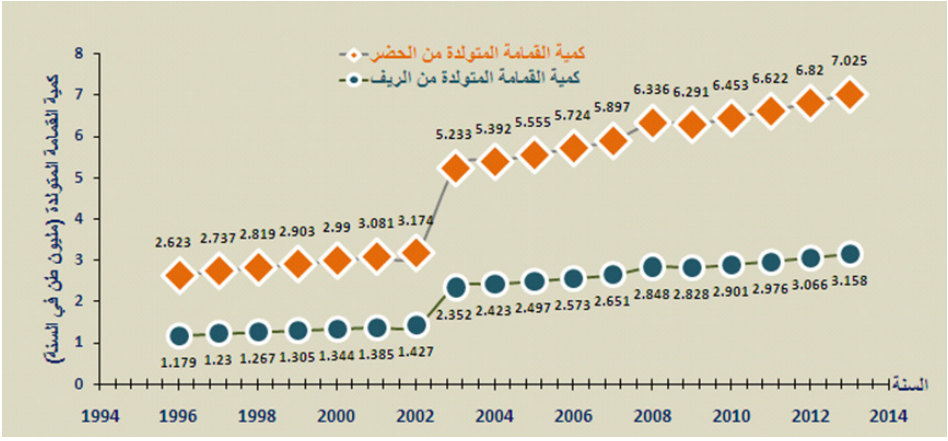


Figure (4) The amount of garbage generated in urban and rural areas in Iraq during the period (1996 - 2013).

Step Four: **Determining the Amount of Each Waste Output in Iraq for the Target Year**

In a study conducted by Dr. Ahmed Abdul Wahab on household solid waste, reverse engineering analysis revealed the potential to calculate what can be extracted globally from primary resource sources in garbage for the year 2020. According to the equation:

There are general conditions that must be met to apply the above equation (No. 3) to find annual estimated data for each type of garbage content.

(x): For the target year.

(a): The amount of garbage in tons generated by a governorate or country for the target year (data unknown).

(b): The qualitative composition of the components of garbage generated by a governorate or country whose sorting and collection data have previously been issued in the Environmental Data Bank for a year such as the year (1995).

(c) the quantity of garbage in tons generated by a governorate or country during the same year whose data is known.

Thus, it is possible to calculate the quantitative composition of Iraq's garbage starting in 1996 and ending in 2020, as in Table (No. 3).

Table 3: Components of Household Solid Waste in Iraq (1995 Estimates)

Item	Produce	Quantity Produced (Tons)
1	Total Garbage Produced	4,706,782
2	Organic Materials Produced	3,197,942
3	Paper	1,048,177
4	Glass	126,849
5	Iron	133,525
6	Plastics	40,058
7	Textiles and Rags	160,231

Source: Environmental Information Bank, Environmental Experts Group at Baghdad Municipality / Department of Solid Waste and Environment.

Furthermore, the composition of modern household solid waste generated in Iraq, particularly since 2003 and afterwards, is entirely different due to it containing high percentages of materials that are difficult to decompose. This reality has led us to deduce the garbage content in each governorate based on the waste composition in Baghdad City by the Department of Solid Waste and Environment in 2012 (Table 4), assuming that consumption patterns in different governorates do not change significantly, hence the difference in components and output ratios in garbage samples depends on the population in each governorate.

Table 4: Qualitative Composition of Garbage Components in Baghdad Governorate (2012 Estimates)

Item	Product	Quantity Produced (Tons)
1	Total Garbage Produced	1,818,403
2	Organic Materials Produced	891,017.47
3	Paper and Rags	343,678.167
4	Plastics	349,133.376
5	Glass	118,196.195
6	Metals (ferrous and non-ferrous)	116,377.792

Therefore, Figures (5–7) are the result of incorporating our available data into Equation (3), and Figure (6) provides a broad framework that compares the composition of garbage waste with that in Greater Cairo and the United States.

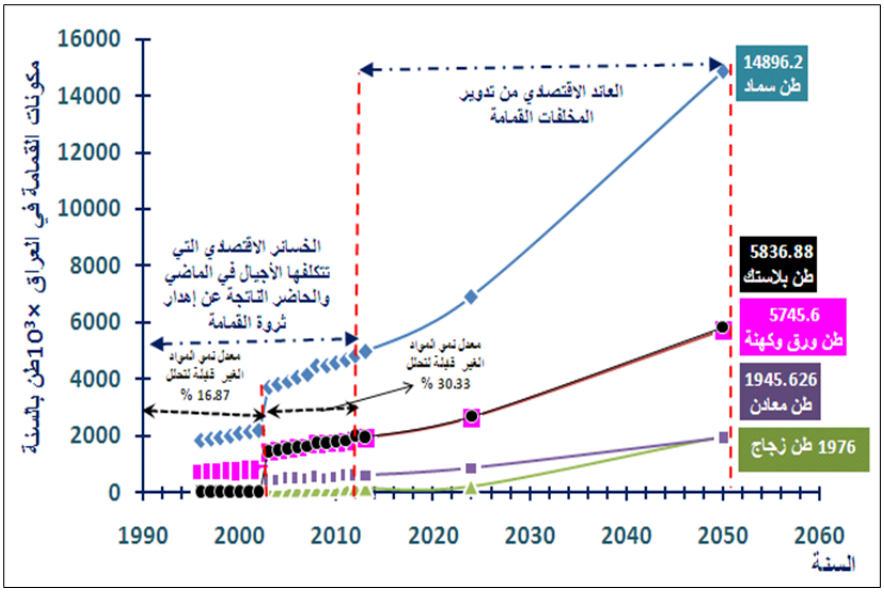


Figure (5) Development in the components of garbage generated from Iraq in the period from 1996–2050.

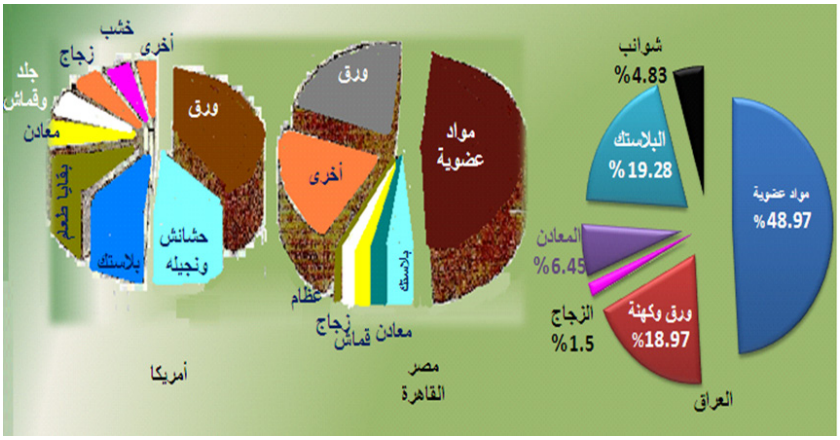


Figure (6) Composition of garbage waste in Iraq compared to Greater Cairo and the United States of America.

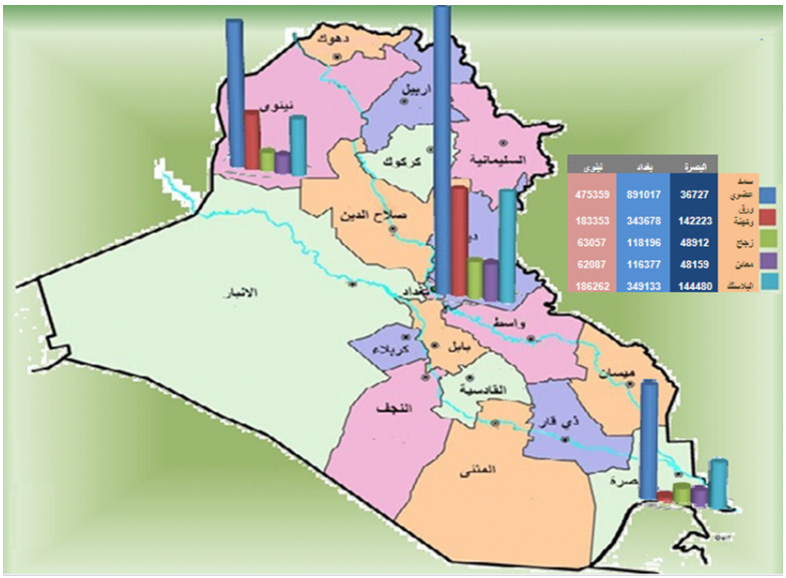


Figure (7) Qualitative composition of the map of garbage components (tons/year) in three Iraqi cities (2012 estimates).

Findings and Discussion:

The results of this study indicate a significant increase in the quantity of household solid waste between 1996 and 2013, rising from 3.8 million tons to 10.18 million tons. This is an approximate 2.6-fold increase over 17 years. The quantity is projected to reach 30.4 million tons by 2050, which will be about 7.9 times the amount observed in 1996. This increase, along with the diversity in quantities of household solid waste, is attributed to the growing population, an increase in living standards, and rapid industrial and technological advancements following the lifting of economic sanctions on Iraq. Today's garbage is filled with plastic bags, metal cans, glass, electronic waste, and other materials. Undoubtedly, garbage represents one of the chronic problems for Iraqis, while fundamentally, it could serve as a national asset potentially representing a source of national income for Iraq. This means transforming garbage from a source of environmental pollution and a breeding ground for various diseases and epidemics into a flourishing and advanced industry that is becoming increasingly successful day by day. Accordingly, Iraq, like many other countries, recognizes the high cost the state incurs—a cost that could have been saved or a loss that could have been avoided by not taking measures to reclaim this lost natural wealth. The current study results, illustrated in Figure 8, show the economic losses incurred by current generations due to the loss of national wealth over the years spanning from 1996 to 2012.

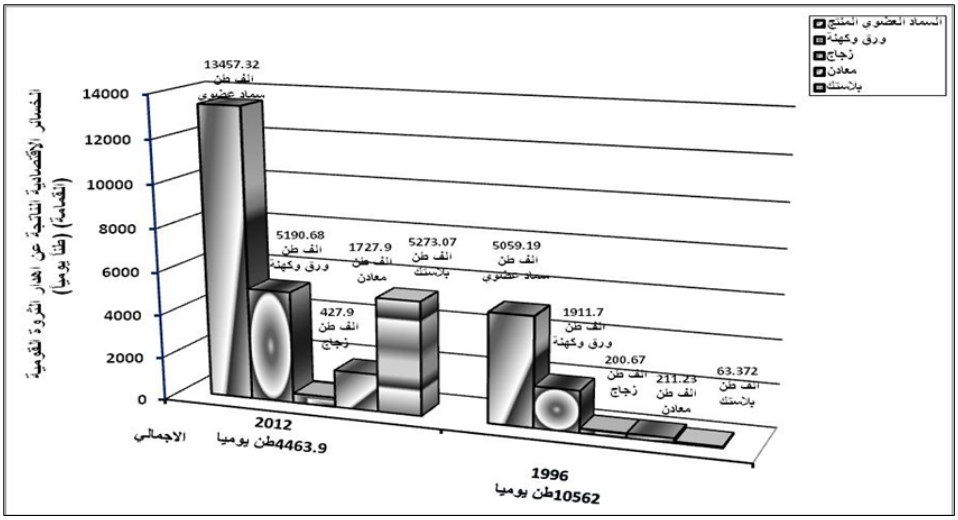


Figure (8) Qualitative composition of the map of garbage components (tons/year) in three Iraqi cities, estimates (2012).

Overall, Iraq has the capability to develop both long-term and short-term national strategies for the effective management of household waste disposal. This current study reveals the estimated value of recycling household solid waste in Iraq for the years 2013 and 2050, as illustrated in Figures 9 to 14 according to global estimates. It is noted that a ton of raw garbage is equivalent in value to a barrel of crude oil.

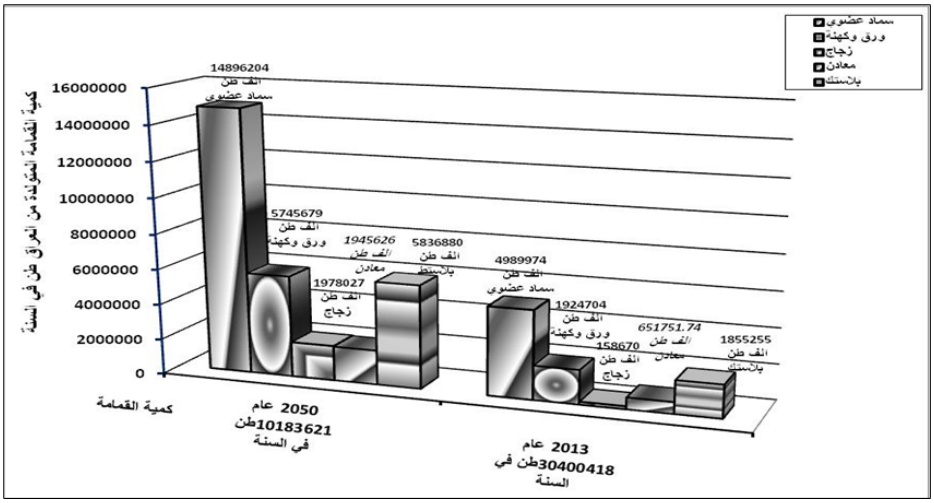


Figure (9) The national wealth that can be produced from garbage in Iraq, now and in the future.

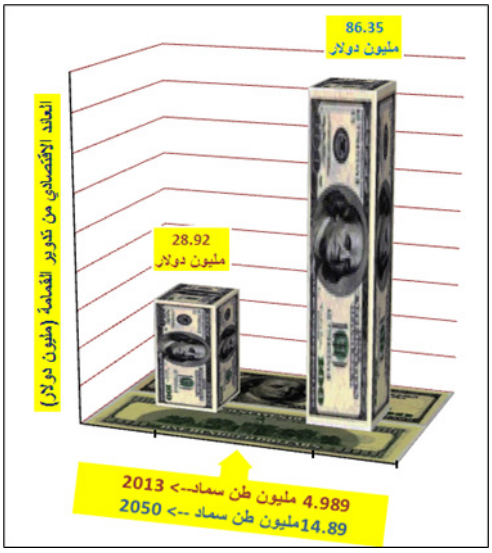


Figure (10) The expected economic return from recycling garbage waste (organic materials as fertilizer).

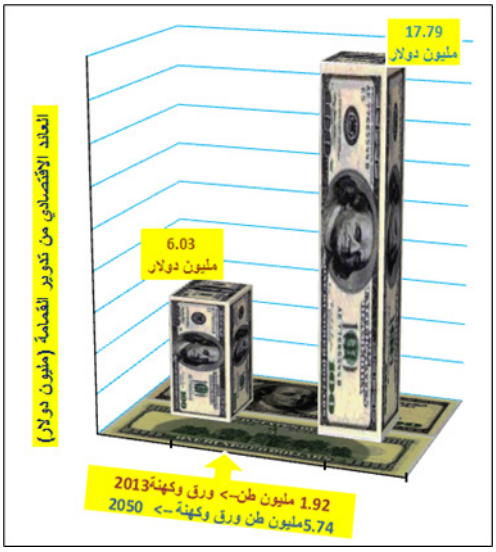


Figure (11) The expected economic return from recycling garbage waste (paper).

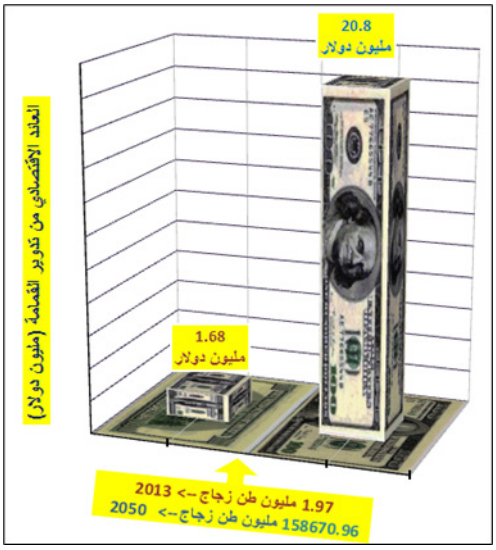


Figure (12) The expected economic return from recycling garbage waste (glass).

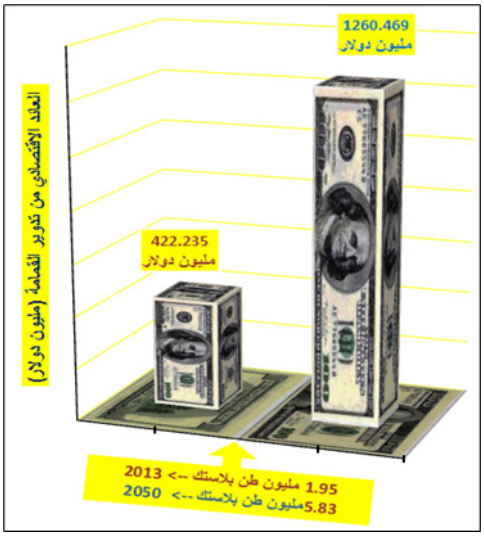


Figure (13) The expected economic return from recycling garbage waste (metals).

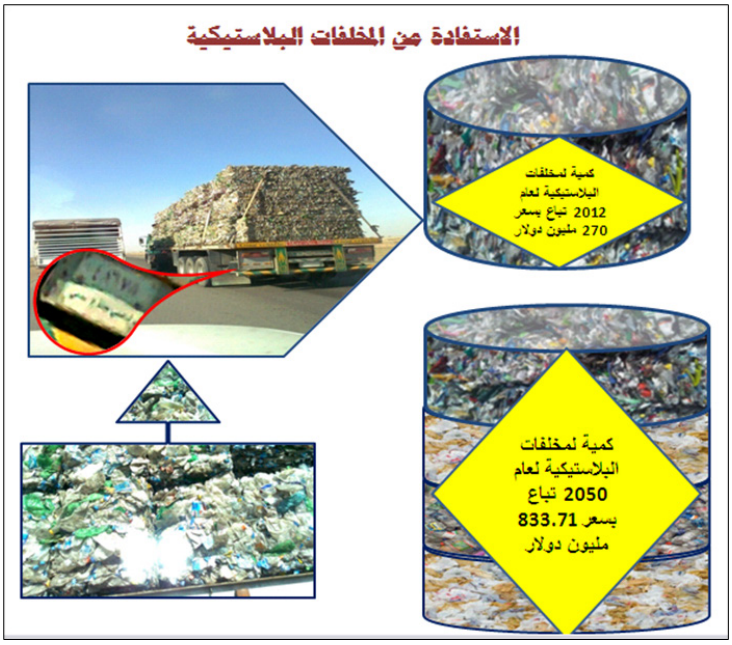


Figure (14) The expected economic return from recycling garbage waste (plastic).

Furthermore, Figure 15 demonstrates the potential to earn $270 million annually by selling plastic waste as raw material to neighboring countries with advanced recycling capabilities. This practice is common in many cities across Iraq. It has been observed that long vehicles crossing border areas are loaded with unsorted plastic waste, which is sold to retail traders.

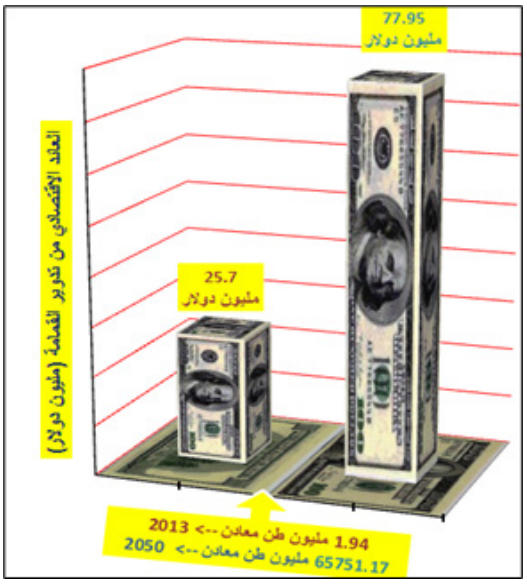
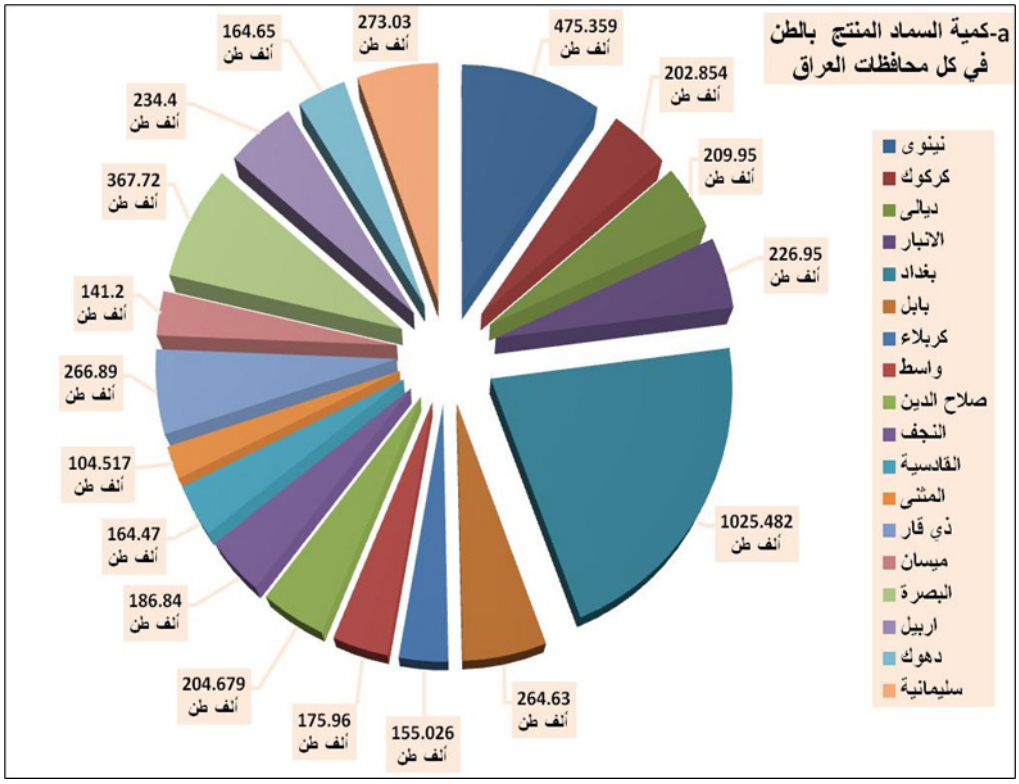
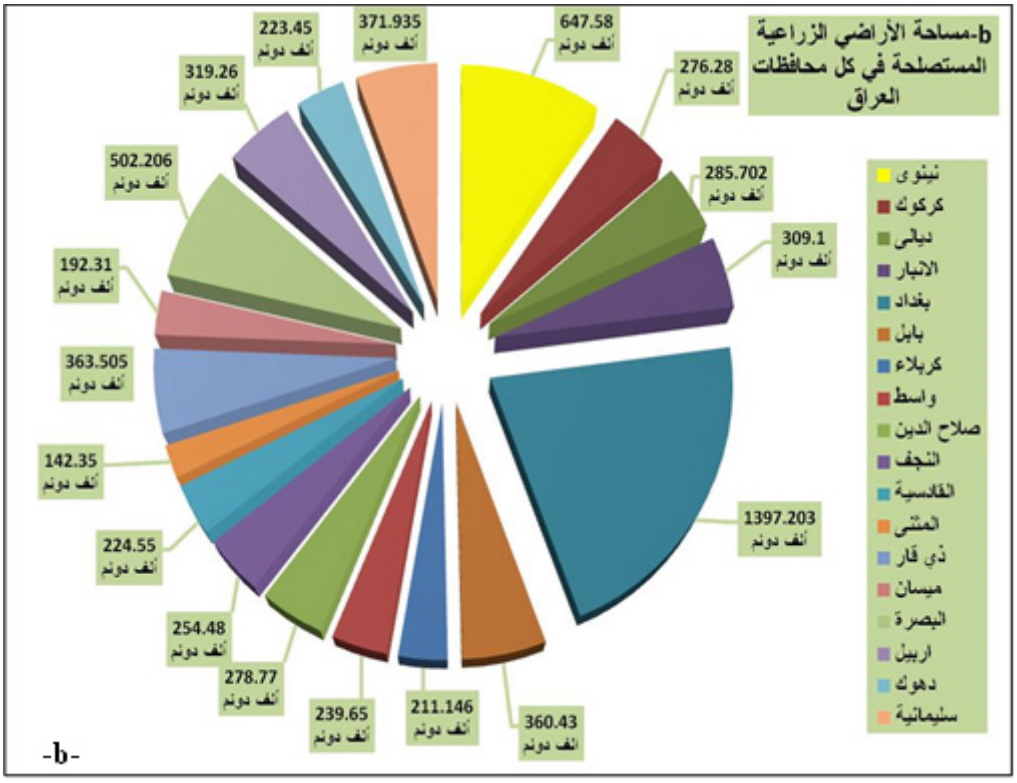


Figure (15) Economic return from selling unsorted plastic waste to retail trade.

The study also clarified that farmers value this as an important source for fertilizing crops and enhancing soil fertility, especially in newly reclaimed land. It was possible to recycle garbage from all the governorates up to 2012, amounting to about 4.8 million tons. Baghdad governorate led in the quantity of organic materials activated in the environment, reaching 1,025,482 tons, followed by Ninewa governorate, which produced 475,359 tons (Figure 16). Therefore,

environmental officials explain the differences in outputs of household solid waste among governorates based on levels, in addition to the variation in population sizes per governorate. The statistics in this study indicated the possibility of establishing several factories to manufacture the aforementioned sorted materials, equivalent to $80.117 million at the end of 2012, expected to reach about $246.345 million by 2050 (these figures are prepared according to a study conducted by Dr. Ahmed Abdul Wahab). This would also provide numerous job opportunities, in addition to the health returns that far exceed the initial investment by avoiding the side effects of environmental pollution caused by garbage.




b-مساحة الأراضي الزراعية المستصلحة في كل محافظات العراق
647.58 ألف دونم
276.28 ألف دونم
285.702 ألف دونم
309.1 ألف دونم
1397.203 ألف دونم
360.43 الف دونم
211.146 ألف دونم
239.65 ألف دونم
278.77 ألف دونم
254.48 ألف دونم
224.55 ألف دونم
142.35 ألف دونم
363.505 ألف دونم
192.31 ألف دونم
502.206 ألف دونم
319.26 ألف دونم
223.45 ألف دونم
371.935 ألف دونم
نينوى
كركوك
ديالى
الانبار
بغداد
بابل
كربلاء
واسط
صلاح الدين
النجف
القادسية
المثنى
ذي قار
ميسان
البصرة
اربيل
دهوك
سليمانية
-b-

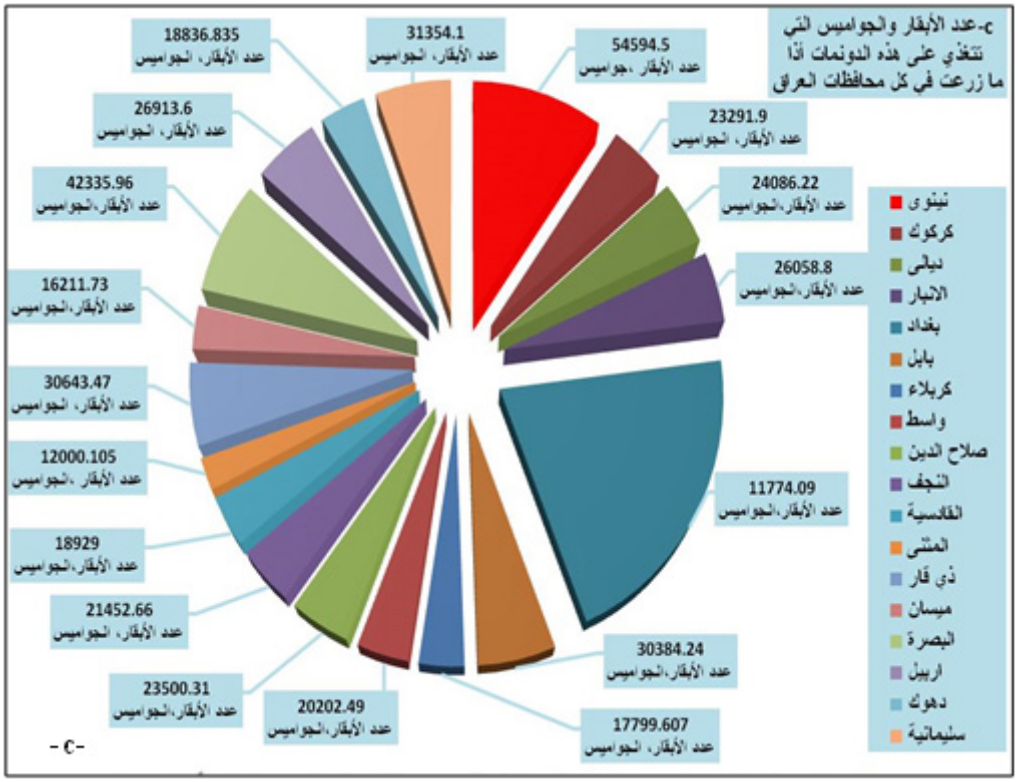


Figure (16) A.B.C. Organic Fertilizer by Governorate and Its Relationship to Reclaiming Their Agricultural Lands and Providing Food for Cattle and Buffaloes After Planting Them with Alfalfa, 2012.

VII. Conclusions:

From the results of this study, we conclude that substantial investments in garbage naturally lead to the creation of an inexhaustible source of national income that will never end. Undoubtedly, this is linked to the extent of the Iraqi citizen's understanding of his environment and his ability to control and harness its resources. Citizens benefit from its useful resources and strive to rid themselves of nuisances that complicate their lives within the environment, such as attempting to remove pollutants, especially modern garbage that now contains materials that are very difficult to decompose like plastic oil bottles, food wrappers made from aluminum foil or plastic-lined cardboard, candles, and plastic bags. According to the recent economic feasibility studies prepared, it is possible to establish several medium-capacity factories for producing paper, glass, iron, plastics, and more, which could employ thousands of unemployed individuals.

Recycling garbage not only benefits the industrial process. It has become possible to replace chemical fertilizers, which pollute agricultural lands with heavy elements, with organic compost known as "Alkumush" produced from garbage. This fertilizer can reclaim thousands of acres of agricultural land.

Recommendations:

The strategy for promoting the recycling of non-hazardous waste (garbage) should be based on six principles:

1. A plan or strategy (for recycling waste or attempting to reclaim sources of primary wealth from it or even reusing it) cannot be established before we have an accurate information bank about these wastes for all the governorates of Iraq as an annual report, in cooperation with the Baghdad Municipality, universities, and specialized research centers.

2. Establish a social fund or an environmental protection fund to set up projects for collecting, sorting, and washing these wastes, each according to its type such as plastic, metal, or paper waste, and then deliver these sorted wastes to the relevant government sector for export to countries advanced in waste recycling such as Turkey, China, and Northern Europe.

3. Egypt, a third world country, has had a successful experience in the field of recycling non-hazardous waste (garbage), and since its environmental problems are similar to those of Iraq, Iraq should adopt and implement this experience instead of following the practices of advanced countries; because their cultures differ.

4. Engage media devices from radio, television, and social media in an active awareness campaign to benefit from garbage and separate its components from the source (household) by providing suitable bins and bags for citizens.

5. Make the subject of material recycling and sustainable development a mandatory part of the curriculum from elementary to high school and then in university education to prepare a generation aware of the importance of dealing with garbage.

6. Cooperate state agencies with businessmen to invest their money in establishing waste recycling factories, providing them with land for free and facilitating licensing procedures.

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