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Research Article

Valorization of Small-scale (Domestic) Organic Household Solid Waste for Market Gardening in Ngor, Senegal: A Case Study

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Abstract

Considering the individual or collective appropriation of food security, can the reuse of organic waste be a waste management solution? The use of organic matter in market gardening. Bio-waste refers to organic waste produced by human and animal activities. In my research, it represents approximately 30% of household waste. Bio-waste can be recovered through composting or methanization. Organic waste recovery should be of interest to many people, and each of them should have reasons for using the organic waste they produce. The objective of this contribution is to demonstrate that the recovery of solid household waste can be a solution for managing urban household waste. The method adopted is essentially based on a combination of techniques for collecting data in the field. This is the so-called empirical method. Following a field assessment, we developed interview guides and created a questionnaire. The underlying premise of this contribution is that the recovery of organic waste helps reduce the amount of waste going into household garbage, and public action should focus on raising awareness among local populations. This contribution is structured around three main areas: firstly, the sorting of household waste (food waste) at the source; secondly, composting methods for this waste; and finally, the use of compost for small-scale market gardening.

Keywords

Valorization, Organic Waste, Market Gardening, Home, Ngor, Senegal

1. Introduction

Solid waste management is considered a public good. Cleanliness and waste disposal are essential for public health and environmental protection [1-3]. Therefore, waste prevention allows for a better reconciliation of socio-economic benefits and environmental protection [4-6]. Waste is now considered a valuable and inexhaustible resource from which raw materials and energy can be extracted [1, 3]. Energy recovery is a technique that provides energy in a world that speaks only of scarcity while getting rid of what interests us least: our waste [1, 7]. This technology becomes almost miraculous when we realize that it also offers advantages in the fight against climate change; the lack of specialized and targeted studies addressing this issue from a scientific point of view in Algeria has reinforced this choice [1-3, 8, 9].

The aim of this contribution is to demonstrate that the recovery of solid household waste can be a solution for managing urban household waste. This article analyzes three main points: firstly, the sorting at source of waste produced by

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households (food waste); secondly, composting methods for this waste; and thirdly, the use of compost for small-scale market gardening will be analyzed.

2. Methodology

The article should be written in English. An article should be between 6 and 25 pages, and exceed 2000 words. For original research articles, it should include the headings Introduction, Materials and Methods, Results, Discussion and Conclusions. Other types of articles can be written with a more flexible structure.

2.1. Donnes and Methods

The method adopted is essentially based on a combination of techniques for collecting data in the field. This is the so-called empirical method. It includes qualitative data, such as interviews, interview guides, and focus groups. Quantitative data, such as questionnaires, is also included. On-site observation allowed for the production of visual material through photography and filming.

2.2. Presentation of the Study Area

The Commune of Ngor (Figure 1), the subject of the study, is located at the western end of the Cap-Vert Peninsula. It is bordered to the east by the Communes of Yoff and Ouakam; to the west, south and north by the Atlantic Ocean.

It covers a total area of 442,082 ha, including 0.496 ha for the islet of Ngor, 11.656 ha for the island of Ngor and 429,930 ha for the rest. It is composed of a compact habitat, mainly located at the level of the traditional village, with originally the old quarters of "*Grand Ngor*", "*Petit Ngor*", *Khatakheli* and "*Ndiogorann"*, the sector known as Ngor Extension, contiguous to Petit Ngor and corresponding to a low sandy-clay area which extends through the old well of *Ngadie* and the quarter known as Ndare, the residential quarters of Almadies and "*Ngor Virage*" which includes the site of the village of the World Festival of Black Arts (FESMAN).

The traditional village is characterized by the narrowness of its alleyways, combined with the close proximity of the population, which complicates any policy of planning and managing services. However, within the framework of the land consolidation of the Almadies and "*Ndare*" sector, the land registry service subdivided this area into 18 zones (Figure 1), which considerably facilitates their addressing for companies such as the Senegalese Water Company (SDE), the National Electricity Company of Senegal (SENELEC) and the National Telecommunications Company (SONATEL).

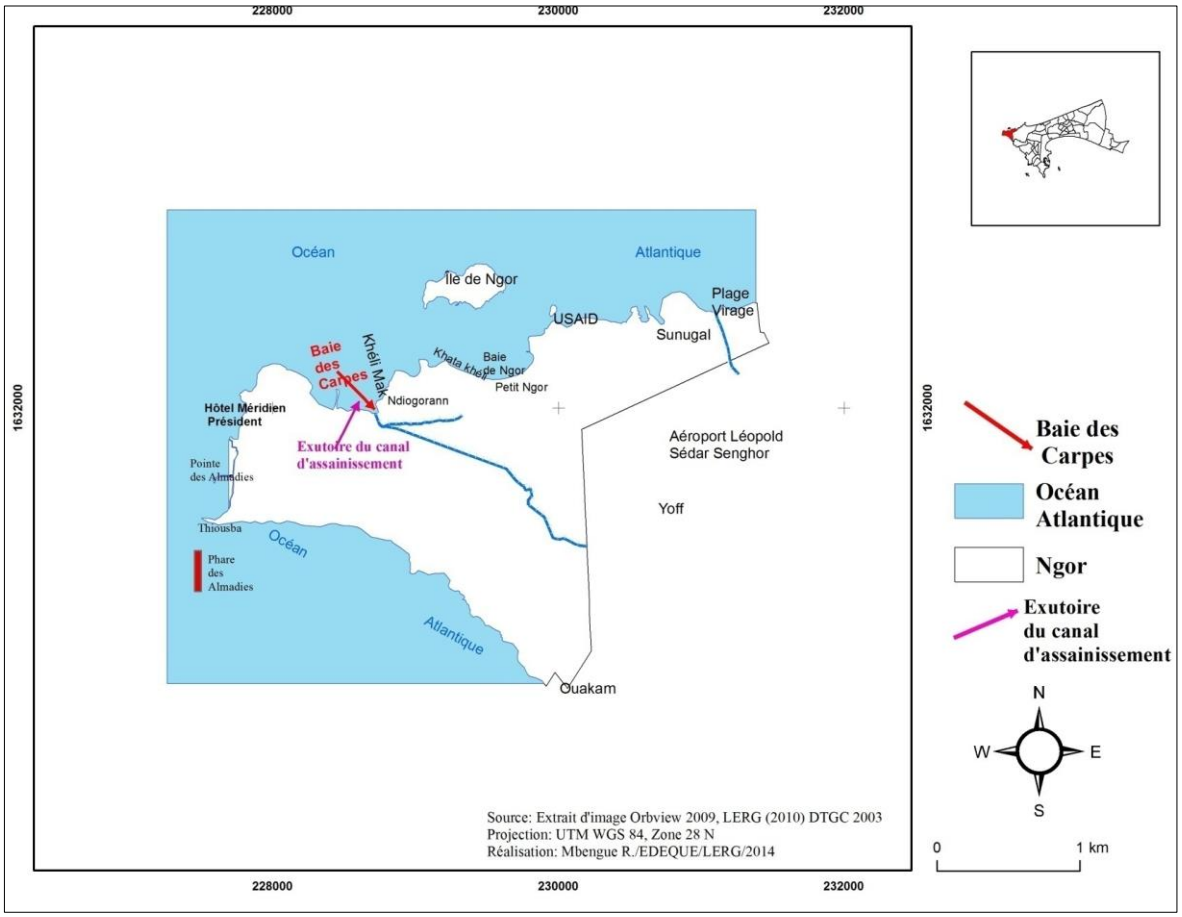

Figure 1. *Location of the study area.*

3. Results

The Materials and Methods section should provide comprehensive details to enable other researchers to replicate the study and further expand upon the published results. If you have multiple methods, consider using subsections with appropriate headings to enhance clarity and organization.

3.1. Waste Production and Storage

3.1.1. Production Waste

Household waste production is significant in the surveyed neighborhoods of Ngor and varies from one area to another (Ngor village and the residential neighborhoods of Almadies). However, in the traditional village, it ranges from a bucket to more than a basin. Figure 2 shows the quantity of waste produced in the neighborhoods. Household solid waste was quantified using standard garbage bags. The use of disposable utensils was not observed. The use of conventional garbage cans was more prevalent. The quantity of waste differs in the residential area, where more than half the waste produced is equivalent to half a garbage can and half a 100-liter bag.

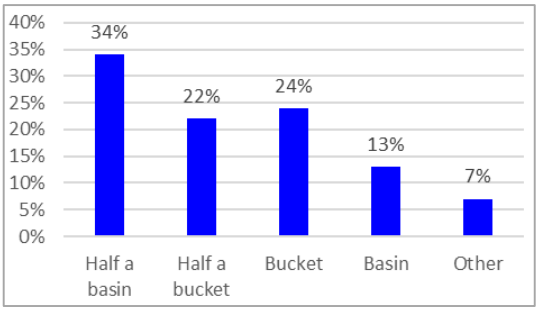

Figure 2. *Estimated waste production in Ngor.*

Household solid waste was quantified using standard garbage bags. The use of reusable utensils is common. Conventional garbage cans are more prevalent. The amount of waste differs in the residential area, where more than half the waste is produced in half a garbage can and half a 100-liter bag.

3.1.2. Waste Packaging

Surveys show that households in Ngor village do not have conventional garbage cans because the price is considered too high by some (Figure 3). For others, frequent garbage thefts often force households to use secondhand (76%) containers that do not meet standards. In Ngor village, only 7% of the surveyed compounds have a regulation garbage can. The residents surveyed reported that garbage collectors throw the bins away; they quickly break and become unusable. In 17% of cases, empty bags, plastic bags, and cardboard boxes are used to package garbage within the compounds.

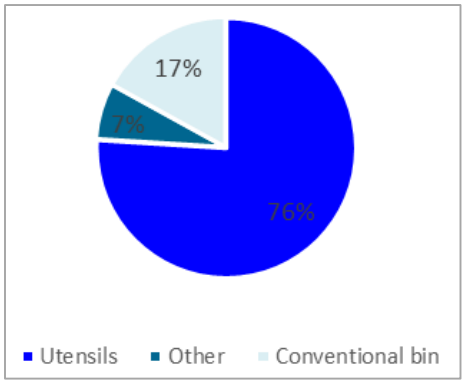

Figure 3. *Types of bin used.*

In summary, all the surveyed properties complied with the regulations for using standard garbage cans. Residents emphasized that using conventional garbage cans spares them the inconveniences of bad odors and flies. However, in Ngor village, the high cost of garbage cans prevents residents from purchasing them. Nevertheless, other types of containers are used by households (Figure 4).

Figure 4. *Method of waste disposal at home.*

Most respondents (73%) stated that garbage could help prevent the spread of odors and germs: once closed, flies, cockroaches, and other insects do not come near the garbage (Figure 4). Garbage disposal locations vary from house to house. Some households store their bins in a corner of the house, while others leave them in front. Using garbage cans and plastic bags facilitates waste disposal and helps manage waste. On Ngor Island, all surveyed households have compliant garbage cans.

3.2. Composition and Classification of Household Solid Waste

The waste stream is a heterogeneous mixture of products and materials whose composition varies according to the source as well as the socio-economic classification of the locality. The results of the field survey reveal several types of household solid waste (Figure 5). A predominance of fine materials was observed in the collected waste, with sand being

the most prevalent by weight. The sifting that was once carried out before storing waste in the bin has been abandoned by households, yet the sand contributes to an increase in the volume of waste and causes rapid deterioration of mechanical equipment. According to the waste collectors, fine materials can make up as much as 50% of the waste collected in some neighborhoods, a situation most noticeable in Ngor village.

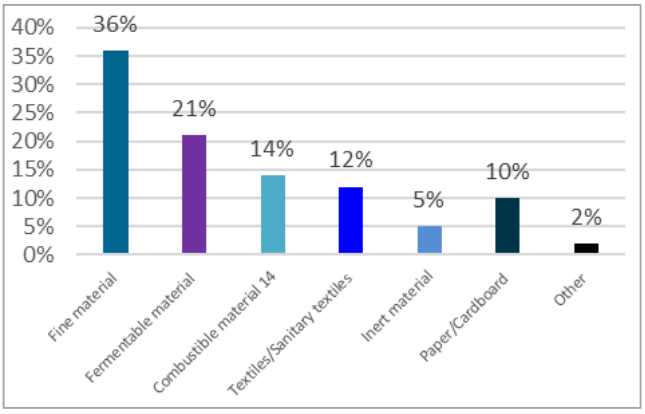

Figure 5. *The composition of solid waste in Ngor.*

Figure 5 shows that this composition reflects the consumption patterns of Ngor households, largely based on fresh produce (fruits and vegetables), combined with the absence of a tradition of consuming canned goods. Plastic is the second most common component of a typical Ngor household garbage bin after organic waste. One consequence of products packaged in bottles relates to liquids: particularly oils, milk, and various beverages (soft drinks, mineral water, and others), and, consequently, plastic bags, the preferred packaging for replacing the traditional basket. However, the composition of waste can vary considerably, both geographically and over time.

3.3. Sorting Waste Producted by Households at the Source

Source separation is an effective method that has allowed for the sorting of waste. It has provided information on the categories encountered during household monitoring. A series of figures were used to illustrate the importance of source separation (Figures 6, 7, and 8).

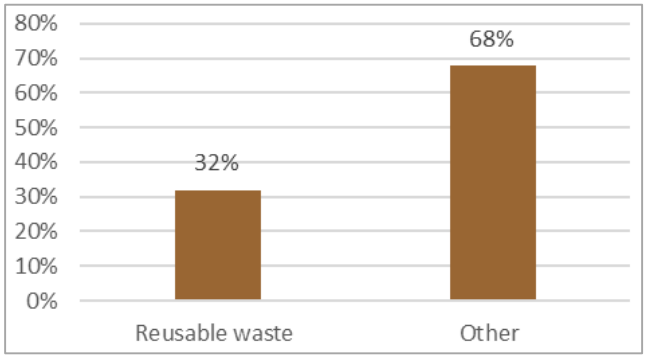

Figure 6. *Reusable waste.*

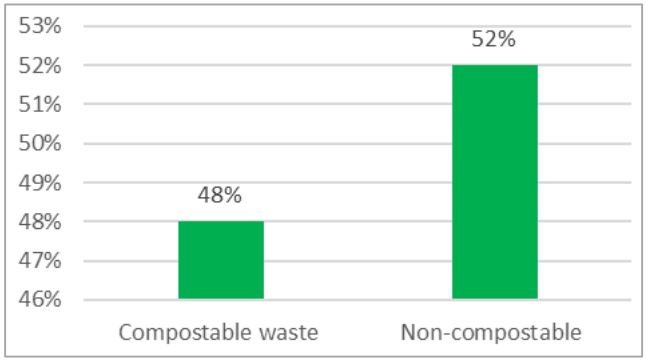

Figure 7. *Percentage of compostable waste.*

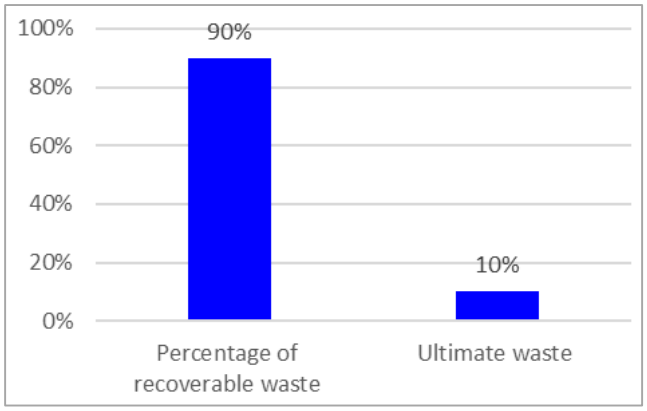

Figure 8. *Ultimate waste.*

3.4. Compostable Waste

Compost waste is what is called organic, fermentable, or biodegradable. Table 1 shows the different types of waste.

Table 1. *Examples of organic waste to compost.*

Nature	Function
Cut fruit and vegetable peelings (raw, cooked or spoiled).	help with decomposition
Banana peels (rich in potassium)	improve the quality of the compost

Nature	Function
Wood chips, sawdust, and small branches	undefined
Coffee grounds, paper filter	undefined
wood ash	undefined
Rice, wheat, millet, bread, pasta (spaghetti, etc.) - raw, cooked, or moldy	undefined
eggshells (crushed, they're better)	decompose more easily
Fish scales (calcium)	undefined
Ears of corn	Undefined
Poultry droppings	undefined e
Fresh (shredded) tree leaves	decompose more quickly
Dried herbs	Undefined
Hay or straw	undefined e
Soil and manure (nitrogen), sheep and goat manure contain microorganisms.	favorable to decomposition and act as activators to heat the pile
Garden waste and grass clippings	undefined e
Seedless weeds	undefined e
Walnut shells, peanut shells, avocado or peach pits	undefined e
Shredded newspaper (good for compost as it's printed with vegetable-based inks)	undefined e
Prepared meals	undefined e
Tea leaves and tea bag	undefined e
Natural, untreated fabric such as wool, cotton, leather, cotton rags	undefined e
Crushed bones (to be isolated and crushed at the composting site)	undefined e
Crushed fish heads	undefined e

Composting organic waste from households allows them to reduce the amount of waste they put in the garbage. This process involves the decomposition of fresh organic matter by bacteria, resulting in rich humus.

Table 1 shows the different types of waste that can be composted. The composting example given here can be done within households. Figure 9 was taken on Ngor Island. It shows a woman making her own compost in her garden, as well as another person composting in a basin (a small, narrow container). Composting allows households to obtain compost to enrich their gardens with humus and facilitate vegetable gardening in their yards. It also helps households reduce their expenses.

Figure 9. *Composting in the home garden.*

Table 2 provides information on the different types of compostable and non-compostable waste.

Table 2. *Nom composting waste.*

Non-compostable waste	Metals (iron/steel, cast iron, copper, aluminum, etc.)
	plastics (all forms of plastic such as PVC, blue or black bags, polypropylene, PET (plastic bottle), lycra, polyester, etc.
	Broken glass and mirror
	Treated wood and plywood sawdust (are toxic)
	Meat (cooked or raw) and bones (whole) attract prowlers
	Fishes
	Liquid waste
	Red or yellow inks from dye works or elsewhere (contain cadmium and other heavy metals)
	Dust from the house
	Diseased plants and plants treated with pesticides
	dairy products (curdled milk, yogurt, leftover "lakh", cheese, butter, etc.)
	Fat (vegetable oils, mayonnaise, vinaigrette, salad dressings, etc.) must be removed from the thieboudiene (fish and rice) with water before it can be composted.
	Wax paper or colored paper
	Seafood shells ("bouthe")
	Animal excrement (dog and cat)
	Wicks

In these two photos, a woman is tending flowers in her home. The compost she uses to fertilize her garden comes from recycling certain materials from waste. Composting is a common practice among both professional and amateur gardeners. It reduces the amount of bagged waste and the risk of environmental pollution.

The following paragraph (Table 2) lists the waste that cannot be composted.

3.5. Methods and Monitoring of the Composting Process Quality: Monitoring the Quality of the Composting Process

Monitoring compost quality involves several phases:

The first phase consists of collecting organic waste produced by households and composting it. Figure 10 shows the waste that was used for composting.

Figure 10. *Organic waste.*

Figure 10: Organic waste collected by the household (Latent phase: After the compost is set up, the temperature needs to rise. For household waste, it is necessary to reach 40 °to 65 ℃ within 2 to 7 days. The high temperature facilitates the decomposition process).

The second phase: This is the hot or thermophilic decomposition phase. Temperatures become increasingly high. They vary between 65 °and 70 ℃ for household waste. This phase is also called sanitization. At this stage, turning should be frequent and watering optimized. Turning should be done every two weeks. The moisture level of the compost should also be checked.

It is important to consider aeration and moisture levels. Aeration is essential since composting is an aerobic process. Poor aeration of the compost pile is the main reason for slow, incomplete, uneven, or smelly composting. It is estimated that air should occupy at least 50% of the pile's volume. To achieve this, the pile should be turned as often as possible to ensure good aeration. The bacteria responsible for compost decomposition need aerobic conditions, meaning they require oxygen to respire. As it decomposes, compost produces heat. Therefore, it is important to aerate the pile well to provide oxygen to the bacteria and maintain a temperature around 70 ℃ (158 ℉). Excessive temperatures kill the bacteria, halting microbial activity. The first mixing should only be done 2 to 4 weeks after the waste has been piled. This prevents the temperature from dropping and preserves bacterial activity. Using a fork, the lower layers are brought to the top. This is the time to incorporate natural activators (urine, poultry manure, seaweed powder, and bone meal) that stimulate activity.

It is also important to monitor the moisture content of the compost. To check if it is adequate, squeeze a handful of compost in your hand. If water droplets begin to appear, the moisture level is good. To check the moisture level, you can use an iron rod inserted into the pile. Compost that is too wet is not good, but it also shouldn't be dry. If the compost is too dry, the bacteria die, and only the fungi continue to work. White mycelial filaments then appear. In this case, the compost needs to be watered again.

The third phase concerns cooling and maturation. The temperature range varies between 40 °and 55 ℃. Finally, we have the stabilization phase (Figure 11), where the temperature should be close to room temperature.

Figure 11. *Evolution of a Compost Process.*

These photos show the composting process and the stages to follow for producing good compost. Monitoring and controlling the aerobic/anaerobic conditions of the process follows the different stages. This can be done by a nasal test, checking the smell of the soil to see if it is fresh or unpleasant.

Following the information obtained on waste that can be composted, anyone can do it. Producing your own compost has many advantages:

1) First, from an ecological point of view, composting allows you to recycle organic waste instead of throwing it in the trash.
2) Second, compost reduces the use of chemical and polluting fertilizers. It contains the nutrients that plants need, which are natural.
3) Finally, it is a way to save on garbage bags or plastic bags.

The waste to be composted is placed directly into the composter to keep the garbage area free of flies, worms, and foul odors, and to prevent cats and rats from getting in. Furthermore, the humus produced significantly improves the soil's water retention capacity.

3.6. Using Compost for Small Scale Market Gardening

Composting takes four months before it can be used at home. Figure 12 shows how the compost is used. Given the limited space available, wooden raised beds are used for tiered gardening. The growing season is slower compared to using chemical fertilizers. The produce from this market gardening process, using repurposed organic waste, lasts longer than produce grown with pesticides or chemical fertilizers.

Figure 12. *Use of Compost.*

In the photos, the tomatoes, cabbages, eggplants, peppers, etc. have just been transplanted. It helps minimize daily purchases of condiments (green onions, parsley, flat-leaf parsley).

4. Discussion

Waste is the result of our daily consumption. It is harmful if left untreated [2, 5, 8-11]. Organic recovery has made it possible to reuse organic waste as compost for home gardening. This process reduces the amount of waste going into a household bin. The results show that waste can be used for other purposes, in this case, reuse for gardening.

Today, waste recovery is a response to economic concerns, environmental protection, and quality of life. It allows for a combination of benefits [12]. This contribution demonstrates that waste can be considered a resource from which valuable things can be created. The example here is the organic recovery of waste for small-scale (home) gardening. Conclusion [12, 14, 16-18].

This contribution highlights the importance of waste composition in the municipality of Ngor. Similar to other African countries, household waste consists primarily of fermentable waste. This composition represents a significant asset for developing composting to enrich agricultural soils [19-25]. This idea is supported by [23]. Considering all the advantages and challenges of composting, the waste market in Africa appears as an opportunity for companies operating in the sector. "The market for organic compounds is extremely dynamic in cities of the developing world in general, and in Africa in particular [9]. Material recovery involves using waste for beneficial purposes such as direct recycling or composting. According to the European Union (EU), recycling is defined as "any operation the principal result of which is that waste is used for a useful purpose by replacing other materials that would have been used for a particular purpose, or that waste is prepared for use for that purpose, in the factory or in the economy as a whole" cited by [24]. According to them, composting constitutes a form of indirect material recovery insofar as it is the waste itself that is used and undergoes a transformation.

In our study, experience shows that composting was carried out aerobically to maximize oxygen production. The waste used for composting was collected during monitoring of the selected households. After collection and storage, the fermentable waste was stacked in windrows. Composting lasted between 8 and 10 weeks. The compost then matured, lasting between 1 and 5 months. The equipment used included a wooden bin, shovel, pitchfork, gloves, and an iron rod to measure moisture. Maturation was indicated by a homogeneous odor, as the waste had mixed with the sand. During composting, seeds from the waste germinated and produced seedlings that were then transplanted. The assessment of compost quality varies among users with limited knowledge of composting. This is a manual composting process that requires minimal resources. There are technical composting processes that require mastery of certain techniques [1, 6, 12-14]. This apparent technicality of the production process, the mastery of which influences the quality of the final product, meant that in 1989, France had 90 composting plants that produced approximately 500,000 tons of compost per year, which was not very well sold due to its perceived poor quality (Bertolini, 1998).

Composting in Senegal is not a recent phenomenon. In 1967 and 1968, a composting plant was built by the French company Omnium sanitation [9]. According to Cisse, the lack of suitable materials led to the plant's closure.

However, the composting experience did not end there. Among the solutions for managing slaughterhouse waste, a methanogenic fermentation unit, Transpaille, was established at the Thies slaughterhouse in 1989 to transform waste into

compost. In addition to compost, this unit also produced biogas [7].

This study shows that organic waste recycling can be done at the household, city, or neighborhood level. It simply requires the will and enthusiasm for small-scale market gardening, involving children in the process. Therefore, recycling organic waste is the best method for a circular economy. It reduces environmental, health, and economic impacts. A storage and processing site must be found for waste after collection. Consequently, households are required to sort and separate compostable waste. For the circular economy to succeed in the municipality of Ngor, the Mayor must support residents in the recovery of organic waste [2, 5, 12-15]. Allocating land for composting is beneficial for those wishing to engage in small-scale market gardening. The recovery of organic waste is an asset that should not be overlooked if we want to live in a healthy environment. It is a collective effort that environmental stakeholders should embrace in order to limit the increase in waste across the territory. Everyone's contribution will give the environment a better, healthier, and increasingly sustainable future.

5. Conclusions

Waste is the result of our daily consumption. It is harmful if left untreated. Organic recovery has made it possible to reuse organic waste as compost for home gardening. This process reduces the amount of waste going into a household bin. The results show that waste can be used for other purposes, in this case, reuse for gardening.

Today, waste recovery is a response to economic concerns, environmental protection, and quality of life. It allows for a combination of benefits. This contribution demonstrates that waste can be considered a resource from which valuable things can be created. The example here is the organic recovery of waste for small-scale (home) gardening.

Abbreviations

FESMAN	World Festival of Black Arts
SDE	The Senegalese Water Company
SENELEC	The National Electricity Company of Senegal
SONATEL	The National Telecommunications Company
PET	Polyethylene Terephthalate
PVC	Polyvinyl Chloride (widely used for plastic bottles)

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Author Contributions

Ramatoulaye Mbengue: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

The data supporting the outcome of this research work has been reported in this manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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Biography

Ramatoulaye Mbengue, a geographer by training, is a lecturer and researcher in the Department of Geography Cheikh Anta Diop University in Dakar, Senegal. She specializes in urban geography, focusing on environmental governance, waste management, rudology, the circular economy, geomatics, remote sensing, and GIS. She defended her doctoral thesis, entitled "Strategy for Waste Management," with a specialization in coastal governance and the coastal environment. This thesis was part of the doctoral program in coastal environment at the Faculty of Sciences and Techniques of Cheikh Anta Diop University in Dakar, Senegal. She has published extensively in peer-reviewed national journals, with the majority of her publications indexed. Her research focuses on environmental governance, quality of life management, the challenges of managing urban solid waste, sanitation, and related issues.

Research Field

Ramatoulaye Mbengue: environmental governance, waste management, rudology, the circular economy, geomatics, remote sensing, GIS