TRADITIONAL KNOWLEDGE, TECHNOLOGIES AND PRACTICE FOR CLIMATE CHANGE MITIGATION: A CASE STUDY OF COMMUNITY COMPOSTING IN CAMEROON

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Using participant observation and appraisal methods, the present study shows that with traditional knowledge, technologies and practices, a significant quantity of household waste was diverted away from the landfill and transformed into organic compost for use by farmers with the possibility of improving existing carbon sinks and reducing net CO_2 emissions.

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Introduction

Traditional knowledge, technologies and practices as highlighted in the UN processes such as the United Nations Framework Convention on Climate Change and the UN Intergovernmental Panel on Climate Change have been documented as cost-effective terrestrial mitigation solutions that have the potential to improve existing carbon sinks and reduce net CO_2 emissions [1,2]. It is on this basis that the contributions of the waste sector to emissions of climate change gases are becoming better understood. At the same time, the important role of the waste management sector as a means through which to mitigate climate change, commonly abandoned in the past, is becoming more recognized. For example, in developing countries, the low cost and simplicity of composting, together with the high organic content of waste make small-scale composting a promising solution. Furthermore, increased composting of municipal waste could reduce waste management costs and emissions, and create both employment and public health benefits. Composting also decreases environmental problems related to the management of wastes by decreasing the volumes of waste sent to landfill and by killing possibly dangerous organisms. A target for European Union countries is to decrease the quantity of organic waste going to landfill sites by 20% by 2010 and by 50% by 2050 (Council Directive 1999/31/EC). The follow-up of this directive could result in a large increase in the composting of organic wastes[3].

In the Industrialized countries, increased composting of household food waste would reduce greenhouse emissions, but would require additional separation of household waste, which may limit the penetration of composting[2]. Notwithstanding, emissions reported to the UNFCCC have shown a stabilizing or even declining trend in recent years for many countries of the developed world[1]. However, the estimation of the past, current and future emissions as well as the mitigation potential in the waste sector has many uncertainties as shown in Fig. 1. According to [4, 5] the most important uncertainties relates to:

- the poor quality of activity data needed for estimation of emissions;
- the data on emissions from the waste sector only extending out to 2020; and
- waste statistics lacking in many countries due to the differences in waste-related definitions and coverage of waste collection.

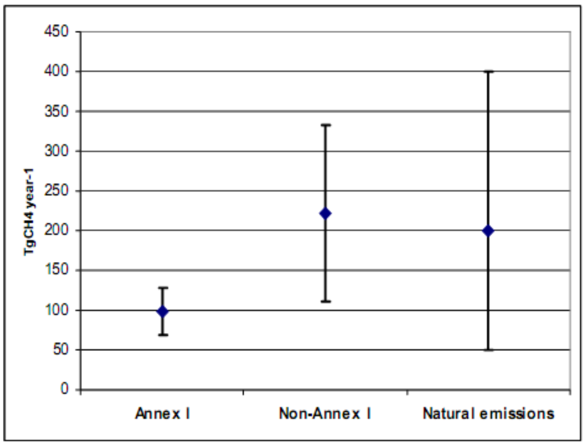

Figure 1. Estimates of total anthropogenic methane emissions from Annex I countries (developed countries) and Non-Annex I countries (developing countries) in 2000 and natural emissions with related indicative approximate levels of uncertainties.[1,8]

It is therefore an undeniable fact that the waste sector is an important contributor to climate change because according to[6], CH_4 produced at solid waste disposal sites contributes approximately 3-4 percent to the annual global anthropogenic greenhouse gas emissions (See Figure 1), and is expected to increase with increasing global population and GDP. Notwithstanding, the use of traditional knowledge, technologies and practices in the production of compost from organic waste for use in agriculture and horticulture could contribute significantly in reducing greenhouse gas emissions; improve soil quality, replacement of chemical fertilizers, reduced use of pesticides, enhanced tilth and less consumption of fuels[7]. This research study makes an evaluation of a community composting in Cameroon from a participatory and rapid appraisal method. In this study, GICABIO was chosen because it is a local community initiative based on sustainable waste management practices with the possibility to generate knowledge that can contribute to policy formulation for climate change mitigation in Cameroon.

History of composting in Cameroon

In response to an increase in the biodegradable fraction of the household waste in Yaounde, Cameroon, youths in the Messa neighborhood and a Non Governmental Organization (PSU), French acronym for Programme Sociale d'Urgence used traditional knowledge, technologies and practices to transform the organic fraction of household waste into organic compost. The composting process lasted about a month with the heap being turned 4 times, after which a ten-week maturation period is recommended. A study done in a ward of the city of Yaounde found out that there were 16 valid market gardening sites which could absorb 8,000 tonnes of garbage per year, i.e. 5 % of all solid waste produced in the city[9]. This traditional initiative was later followed by research at the Higher Polytechnique College of Yaounde in 1992 to forge out a scientific method for composting[10]. With the support of PNUD and French Cooperation Agency[11], 15 composting sites based on traditional knowledge and practice became operational in Yaounde. Other towns like Bafoussam, Bafang, Nkongsamba, Garoua [11-13] also got involved in composting but not without numerous setbacks such as short period of funding by donors, low selling price, little or no financial compensation from the citizens[14].

The relevance of the composting

Composting is a range of processes involving thermophyllic aerobic micro-organisms to convert organic waste materials into stable humic substances and inorganic plant nutrients (compost). Composting involves a multiplicity of physical parameters and feedstock varying simultaneously. Therefore, an efficient compost production requires a thorough understanding of the process dynamics in terms of the feedstock materials used and the interactions of the physical parameters (Table 1) such as temperature, moisture content, bulk density, porosity and oxygen availability.[15-17]

The micro-organisms involved in the composting process include bacteria of the species Actinomycytes and fungi (moulds and yeast) while the by products are carbon dioxide, water and heat energy[15]. However, applying compost to soil not only increases the total organic carbon (TOC) but plays an important role in microbial proliferation and activity[18]**.** Although the application of compost is considered a suitable tool for mitigating climate change and improving soil fertility, very few studies have been conducted in semiarid climates to evaluate the joint effect of such practice on the structure and function of the soil's microbial community**.**

Table 1. Characteristic of compost for use in agriculture[15].

Agricultural Parameters	Reported as (units of measure)	Recommended Range
pH	pH units (1:5 water extract)	7.0 – 8.7
Moisture Content	% m/m of fresh weight	35 – 55
Organic Matter Content	% dry weight	>25
Screen aperture size	mm	40 maximum for soil improvement 25 maximum for top dressing grassland
C:N Ratio		20:1 maximum

Despite the lack of sufficient knowledge, compost use (see Table 2) has an important task to play in making both the developed and the developing countries more environmentally sustainable. This can be made possible given the fact that composting is higher in the waste management hierarchy than landfill, hence an environmentally friendly and economical alternative method for treating solid organic waste, thus reducing the amount of waste to be transported and discarded in landfills and built environments. It can also be a valuable source of raw material (fertilizer) for agriculture and as an income generator.[15,19-22]

Compost also has the potential of replacing about a million cubic metres of peat per annum, to meet its obligations under the Biodiversity Directive, and to support sustainable agricultural practices by returning nutrients to the soil and averting the decline in soil quality. Composts help to increase soil functionality and elasticity, and maintain biologically diverse habitats. This will help protect soils against powerful rainfall events and extended summer droughts, a very common scenario in Sub-Sahara African countries[24]**.**

According to[25], agricultural production in Sub-Sahara African Countries has indeed been sensitive to climatic changes. Figures 2 and 3 provide graphical illustration of trends in rising temperature and declining precipitation and climatic changes for Sub-Sahara African (SSA) and Non Sub-Sahara African (NSSA). Therefore, compost use can supply some nutrients which can effectively replace artificial fertilizers and improve soil buffering capacity and reduce nitrogen leaching. Notably, composts derived from biodegradable wastes have the potential to off-set carbon dioxide emissions equivalent to over a million cars a year through carbon sequestration.[24]

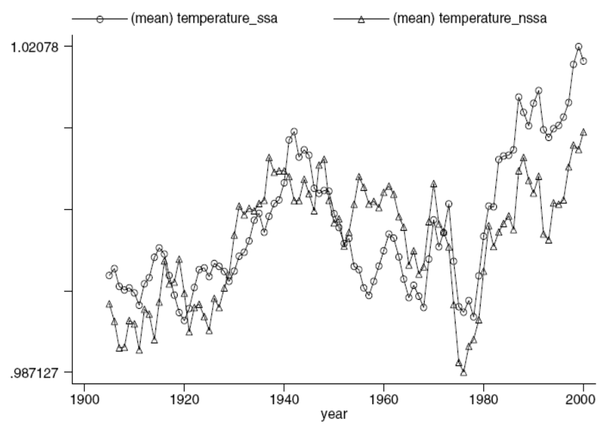

Figure 2. Normalized mean temperature for Sub-Sahara African (SSA) and Non Sub-Sahara African (NSSA) countries [25]**.**

Table 2. The use of different types of compost[23].

Type of compost	Properties/parameter	Mode of use	Amounts of compost
1. Green compost	Organic matter	Mulching or soil amendment[a]	3–10 cm layer or 10–600 ton ha^{-1a}
2. Compost from household waste	N-content, stability and phytotoxicology	Mulching or soil amendment	33–6 cm layer or 100–150 kg N ha^{-1b}
3. Compost with municipal sludge	Ca and pH, N, organic matter	Soil amendment	100–150 kg N ha^{-1}, or according to the liming effects
4. Soil mixes	Variable	Growing medium	Depending on the conditions

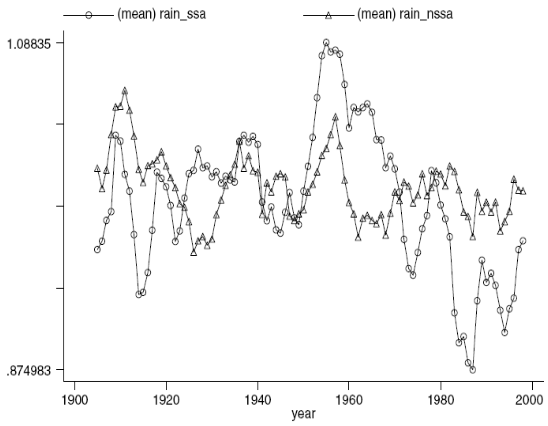

Figure 3. Normalized mean rainfall for Sub-Sahara Africa (SSA) and Non Sub-Sahara African (NSSA) countries[25].

Materials and methods

Site description and field study

Cameroon is located in Central Africa and bordered on the west by the Gulf of Guinea, north west by Nigeria, north east by Chad with Lake Chad on its northern tip, east by Central African Republic and to the south by Congo and Gabon[26]. A socio-economic survey was conducted on four neighbourhoods (Banengo 1, Bamendzi, Ndiandam, Kouogouo) in Bafoussam, the capital town of the West Region in Cameroon. The aim was to determine local community / voluntary group activity, availability of kerbside recycling and regularity of collection services by a local waste collection company, HYSACAM. Added to this was to provide a clue on household waste arisings and the way it was being perceived and managed.

Participant observation and appraisal methods were used to evaluate the composting process (Fig. 4). Participant observation is a method in which the observer participates in the daily life of the people under study either openly in the role of researcher while participatory appraisals is an approach of learning about communities that places equal value on the knowledge and experience of local people with different background and experience and their capacity to come up with solutions to problems affecting them[27].

Results and Discussion

Since its inception in 1995, the GICABIO project has had a positive socio-economic and environmental impact in Bafoussam, the regional capital of the West Region of Cameroon. Environmentally, of the 80 tonnes of household waste produced daily and destined for the landfill, approximately 10 tonnes were collected and transformed into compost[28]. Socio-economically, it has improved the livelihood of 200 unemployed youths who earned some money from the collection and transportation of household waste to compositing sites as well as enabled Cameroonian farmers to have access to a cheap compost to fertilize their farmlands. Between January and June 27, 8 tonnes of compost was produced[28]. Despite this success, numerous constraints were identified. The fact that the composting activity was done manually puts plenty of strain on the workers. Transportation cost was observed as a major barrier to willingness-to-pay (WTP) for compost in the study area. In line with[29]**,** the effective demand for compost for agricultural purposes in Cameroon is marginal and restricted by farmers transport costs. In a study to estimate the demand for municipal waste compost via farmer's willingness-to-pay (WTP) in Ghana,[29] it was reported that, the majority of respondents were positive in their responses and perceptions in the demand for compost. The WTP analysis (profit analysis) was important in highlighting variables, which explain variations in the WTP and in due course allows the quantification of the compost demand under different scenarios of subsidized and non-subsidized compost. Irrespective of the inconsistencies observed in the farmer's WTP, the low market price (1.5 US Dollars) compared to 5 US Dollars for mineral fertilizer was responsible for the increase use of organic compost in agriculture (Fig. 4) e.g. (demonstration farms, tomato, beet root, cabbage, lettuce and green vegetables) and horticulture (flower nurseries and gardens).

The absence of complementary standards governing application to land however raises questions on the effectiveness of traditional knowledge, technologies and practices in improving existing carbon sinks and to reduce net CO_2 emissions. Despite these uncertainties, decomposition at the pilling and maturation phases of the composting process (Fig. 4) depended on the climatic condition (Fig. 2 and 3) and the type of waste (Table 2).

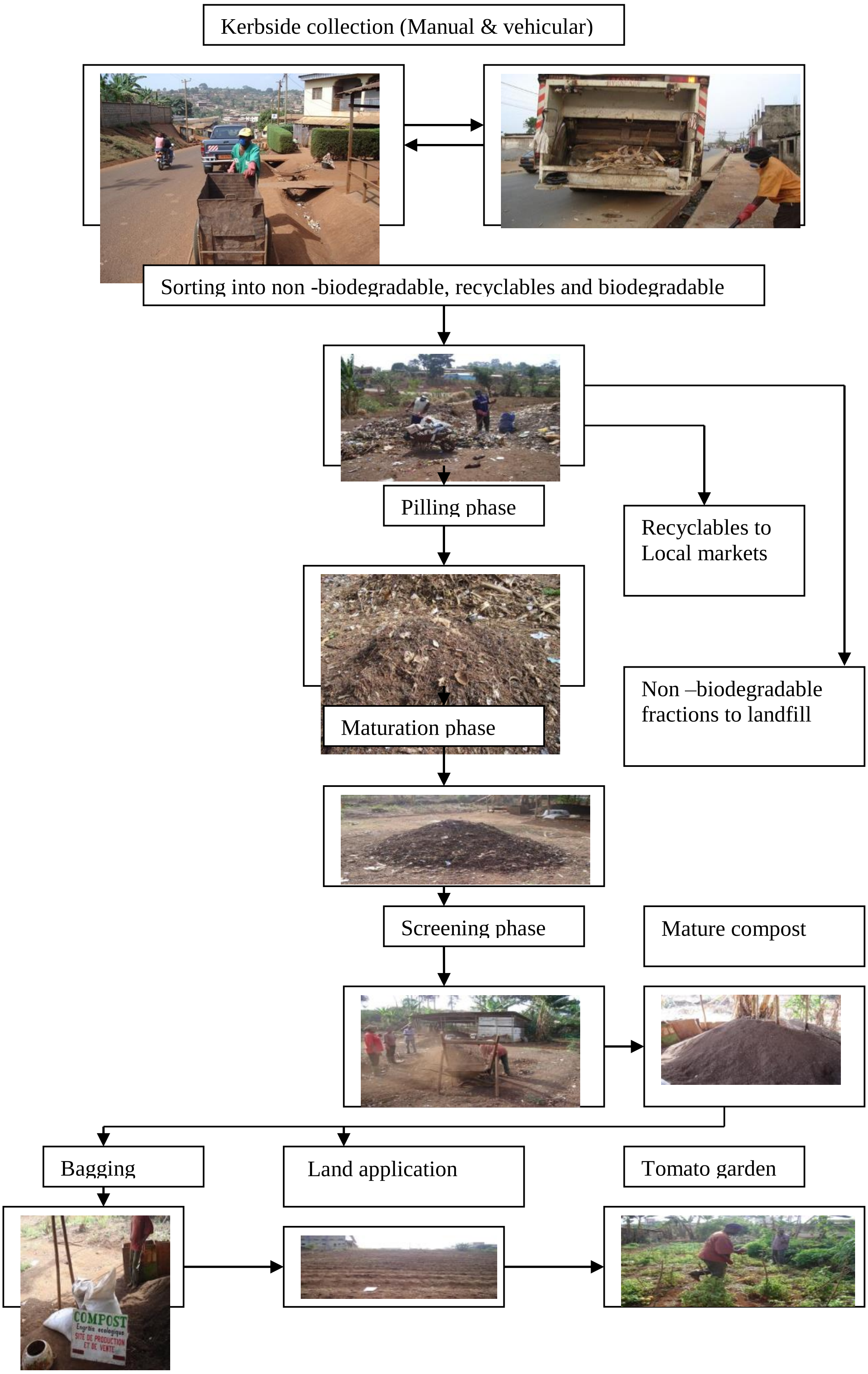

Figure 4: Flow Chart of the composting process and application

Cameroon, like in other Sub-Sahara African countries with rising temperatures and declining precipitation[25], the decomposition process is slow and takes several months, 3 to 4 months during the raining season and 4 to 5 months in the dry season.[30] Under such conditions, to estimateemissions during the composting process requires data on the type and composition of the waste to be composted. However, in the absence of such data it becomes impossible to calculate the mitigation potential of composting to climate change. Although not within the scope of this work, the results indicate that a significant quantity of household waste was being diverted away from the landfill which is in line with the European Union directives (Council Directive 1999/31/EC).

Conclusions

The GICABIO study highlights the importance of using traditional knowledge, technologies and practices in compost production and indicated that a significant quantity of household waste was being diverted away from the landfill and transformed into organic compost for use by farmers, with the possibility of improving existing carbon sinks and reducing net CO_2 emissions. Climatic conditions and the waste types were determining factors for the quality of the compost that was produced. However, in the absence of compost specification, and data on waste characterization, uncertainties reigns as to the effectiveness of traditional knowledge, technologies and practices in improving existing carbon sinks and to reduce net CO_2 emissions. It is for the reason that this work recommends that, traditional knowledge, technologies and practices should be integrated with modern composting technologies to better understand the mitigation potentials to climate change.

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