

Vermicompost as a fertilizer for urban and peri-urban farms: Perceptions of farmers in Accra, Ghana

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ABSTRACT

Vermicompost is considered a valuable organic fertilizer in many tropical regions, but has rarely been used in sub-Saharan Africa. A study in Accra, Ghana, assessed urban and peri-urban (UP) farmers' fertilizer and pesticide use, knowledge of earthworms, fertilizer performance criteria, and attitudes toward vermicompost as a fertilizer. Twenty-six farmers involved in irrigated vegetable farming and three subsistence farmers were interviewed. Farmers were aware that earthworm activity was associated with soil fertility, and some associated insecticide applications to reduced earthworm populations. Farmers used the greenness of leaves, crop emergence, stand and yield as indicators of fertilizer performance. Farmers resisted making statements about vermicompost before testing it, and advised that its fertilizer value be tested during the dry season. Farmers involved in irrigated vegetable farming had insufficient space and time for on-farm vermicomposting, while subsistence farmers lacked a reliable access to water necessary for on-farm vermicomposting; but both types of farmers were interested in adopting vermicompost if it improved crop performance. Such lack of farm resources suggest that a commercial facility would be best suited to produce vermicompost from organic waste, which would then be sold to farmers.

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RÉSUMÉ

MAINOO, N.-O. K., BARRINGTON, S. & WHALEN, J. K. : *Vermicompost comme engrais pour les champs urbains et péri-urbains: La perceptions d'agriculteurs d'Accra du Ghana*. Vermicompost est considéré un engrais organique valable en plusieurs régions situées entre les tropiques mais il a été rarement employé en Afrique subsaharienne. Une étude a été faite à Accra au Ghana pour évaluer l'usage de pesticide et d'engrais d'agriculteurs urbains et péri-urbains (UP), connaissance du ver de terre, critère pour la performance d'engrais et les attitudes vers le vermicompost comme engrais. Vingt-six agriculteurs de la culture de légume irrigué et trois agriculteurs de subsistance étaient interrogés. Les agriculteurs étaient au courant que l'activité du ver de terre était liée à la fertilité du sol et quelques applications d'insecticide y liées pour réduire les populations du ver de terre. Les agriculteurs employaient la verdure de feuilles l'émergence de culture, l'étendue et le rendement de culture en tant qu'indicateurs de la performance d'engrais. Les agriculteurs résistaient des commentaires sur le vermicompost avant de l'essayer et conseillaient l'essai de ses valeurs d'engrais pendant la saison sèche. Les agriculteurs de la culture de légume irrigué avaient d'espace et de temps insuffisants pour la production de vermicompost sur le champ alors que les agriculteurs de subsistance n'avaient pas d'accès sûr à l'eau nécessaire pour le mélange de vermicompost sur le champ, mais les deux types d'agriculteurs s'intéressaient en l'adoption de vermicompost à condition qu'il améliorerait la performance de culture. Le manque de telles ressources au champs suggère qu'une installation commerciale pourrait être la plus mieux convenable pour la production de vermicompost à partir de déchets organiques qu'on pourrait ensuite vendre aux agriculteurs.

Introduction

The need for organic fertilizers in sub-Saharan Africa is urgent because soils in the region are generally highly weathered and have low fertility (Stangel, 1993). The total loss of nutrients, annually, across arable lands in sub-Saharan Africa, was forecast to reach 26 kg N ha⁻¹, 7 kg P₂O₅ ha⁻¹, and 33 kg K₂O ha⁻¹ by 2000, with the most severe nutrient mining projected to occur in densely populated areas (Stoorvogel, Smaling & Janssen, 1993). Breman (1990) concluded that applying mineral and organic fertilizers was the only way to address the problem. Farmers practising subsistence agriculture are more likely to exhaust inexpensive internal inputs (organic fertilizers produced locally) before opting to purchase expensive external ones (mineral and organic fertilizers transported from outside the local region). Vermicompost, an organic fertilizer created from the treatment of organic waste by earthworms, could be a good internal input for poor urban and peri-urban (UP) farmers in sub-Saharan Africa. Using vermicompost is a potential "win-win" situation, because earthworms can divert large quantities of organic wastes from urban dump sites and produce an inexpensive, nutrient-rich fertilizer at a low cost for local UP farmers.

African farmers have some knowledge on how to manage soil fertility with mulching, cover crops, and green-manuring. Growing evidence suggests that some farmers can accurately assess the quality of organic fertilizers and use the knowledge strategically (Lekasi *et al.*, 2003). For example, farmers in the Kano Close-Settled zone, Nigeria, considered bird (chicken, duck and turkey) manures to be of best quality based on nutrient value; and also considered manures produced by small ruminants to have the most consistent quality (Harris & Yusuf, 2001). Nigerian farmers reported that rainy season manures were best suited for millet and dry season manures for peppers. Another study in the Kiambu District, Kenya, observed farmers ranking manures by crop response (Mwarasomba *et al.*, 1995). It is,

therefore, logical to assume that for vermicompost to be adopted by farmers in Accra, it will have to fit into the local farming system and farmers' livelihood strategies (Saidou *et al.*, 2004). Farming practices such as pesticide use, organic and inorganic fertilizer use, and farmers' knowledge of earthworms will affect the level of adoption. Vermicompost should perform as well as other organic fertilizers, based on farmers' fertilizer performance criteria, and must be introduced in a manner acceptable to farmers.

This study was about introducing pineapple waste vermicomposting in Accra, Ghana. Its objectives were to report on pesticide and fertilizer use by UP farmers, determine farmer's knowledge of earthworms, assess farmers' fertilizer performance criteria, and to evaluate farmers' attitudes toward introducing vermicompost as a fertilizer.

Materials and method

Study area

The study was conducted in Accra, Ghana, between February and May 2006. Accra is in the southern coastal savannah belt of the country along the Gulf of Guinea (5° 34' N, 0° 10' W) (Twumasi & Asomani-Boateng, 2002). The city's settlements occupy an area of 751 km² (Møller-Jensen, Kofie & Yankson, 2005) with a general elevation of 75 m above sea level. The mean monthly temperature ranges from 24.7 °C in August to 28.1 °C in February, and the mean annual rainfall is 846 mm. The rains fall mostly from May to July, and also from September to November (Twumasi & Asomani-Boateng, 2002).

The agricultural practices in and around Accra and its surrounding suburbs are typical of urban agricultural activities. Seven urban agricultural types have been observed: backyard gardening, fish farming, livestock farming, irrigated vegetable gardening, small ruminants and poultry, seasonal crop farming, and miscellaneous, which entails raising export crops, micro livestock, snail farming, and bee-keeping (Danso *et al.*, 2004). Irrigated vegetable gardening is the dominant practice

(Armar-Klemensu, 2000), occurring on up to seven open spaces across the city (Obuobie *et al.*, 2006). In this study, open spaces are defined as undeveloped spaces, some distance from human dwellings, beside drains, stream banks, roadsides, abandoned waste dumps, around public buildings, and on private lands that have been left idle (Obuobie, Danso & Drechsol, 2003). Some of these sites have been cultivated continuously for the last 50 years (Danso *et al.*, 2004). In Accra, irrigated vegetable farming occurs on 47 ha in the wet season, and on 100 ha in the dry season (Obuobie *et al.*, 2006).

Qualitative data collection

Qualitative data can help researchers understand the beliefs and attitudes of farmers toward different technologies (Enyong, Debrah & Batiano, 1999). In this study, the qualitative data were collected through open-ended interviews with farmers. As in Desbriez *et al.* (2003), conversations were guided toward selected

topics while remaining flexible enough to contain any other topics of interest to the respondents. The objectivity of the responses from interviews was preserved by triangulating responses between stakeholders, whilst preserving confidentiality, as recommended by Berardi & Donnelly (1999). Data collected from interviews were augmented with general observations by the researcher during field visits and from other reports.

Twenty-nine urban farmers were interviewed and important points were recorded in a notebook. Urban farmers, in groups of two to three individuals, were asked a series of open-ended questions concerning their farming practices (pesticide and fertilizer use), earthworms and earthworm habitats, how they evaluate fertilizers, and other general issues concerning fertilizer performance (Table 1). All farmers interviewed were approached as they worked on their beds. The same researcher conducted all interviews for consistency.

TABLE 1

Open-ended Questions Asked of Urban Farmers in Accra During This Study and Justification for Queries

<i>Question</i>	<i>Justification</i>
What crops are grown and for what purpose are they being grown?	To assess purpose of farming activity, especially economic motivation
What are the differences between organic and inorganic fertilizers?	To assess farmers' knowledge on soil fertility management
How is fertilizer performance evaluated?	To assess farmers' criteria for evaluating fertilizer performance
Are earthworms beneficial or detrimental to soil quality and fertility?	To assess farmers' perceptions on earthworms and their benefits to soil fertility
Are earthworms present on farms?	To assess farmers' perceptions on earthworm abundance on farms
Where are earthworms found?	To assess farmers' knowledge on local earthworm habitats
How should vermicompost be evaluated?	To assess farmers' strategies for evaluating vermicompost performance
Is there any interest in applying earthworm castings, from earthworms fed organic wastes, on farm beds?	To assess farmers' perceptions on adopting vermicompost

Results and discussion

General description

The farmers interviewed had a mean age of 43, and ranged in age from 24 to 62 (Fig. 1). Most farmers were illiterate, although two had completed primary school. Only one of the interviewees was a woman, confirming the gender imbalance in commercial irrigated vegetable farming in Accra reported by Obosu-Mensah (1999), Obuobie, Drechsel & Danso (2004), and Danso *et al.* (2004). Other women were approached for interviews, but they asked the men to answer queries whilst they

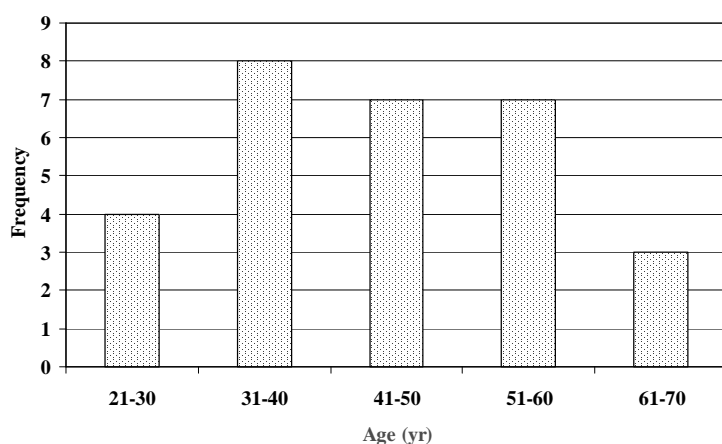


Fig. 1. Age distribution of 29 urban farmers from Accra interviewed during this study.

tended their beds. Although age, educational background, and sex may affect farmers' perceptions, it was impossible to evaluate these factors in this study because of the gender imbalance and the high rate of illiteracy among the farmers interviewed. Group interactions with farmers also made it difficult to separate the responses from elderly and younger respondents in the same group. Twenty-six farmers cultivated beds in a chain of irrigated vegetable gardens on vacant plots, west of the Kotoka International Airport. As reported by Obuobie *et al.* (2003), farmed lands were always adjacent to major drains in which water was available for irrigation. Here, farmers did intensive year-round irrigated vegetable farming, cultivating spring onions,

lettuce, cabbage, carrots, beet root, green peppers, cauliflower, tomatoes, and cucumbers. The remaining three farmers were squatting on University of Ghana property to the east side of the Campus. These farmers practised rainfed subsistence farming with little or no external inputs. They grew cassava, tomatoes, okra, garden eggs, pepper, and maize. None of the 29 farmers had legal tenure to the land they were cultivating. The researchers assumed that they were in some informal agreement with landowners (private and public), who in turn benefited from

farmers keeping the land clear of weeds and preventing encroachment by land developers and other squatters (Obuobie *et al.*, 2003, 2006).

The frequency of responses are presented in the ensuing paragraphs and put in brackets.

Fertilizer and pesticide use

Farmers (23) appreciated the value of organic fertilizers, especially the chicken manure-sawdust mix (CM) that could be purchased at US\$0.10 to US\$0.30 per 0.30 to 0.35 kg bag (Danso *et al.*, 2006). Organic fertilizers, including CM, cattle dung, black soil and even human excreta, were widely used by UP farmers in Accra, Kumasi and Tamale (Danso *et al.*, 2006), but farmers preferred CM because of its low price, effectiveness (high content of available nutrients for plant growth), and long-term effects on soil. Some farmers (11) stated that they applied CM to reclaim saline soils for cultivation, because inorganic fertilizers were ineffective on such soils. A few farmers (4) also mentioned using CM to increase soil water holding capacity. One farmer stressed that applying inorganic fertilizers indiscriminately increased post-harvest spoilage. All vegetable farmers also applied inorganic fertilizers on their farms. Popular inorganic fertilizers

included NPK (15-15-15 and 20-20-20), urea, and mono-ammonium phosphate (MAP). When CM was applied, it was usually in combination with inorganic fertilizers, or on problematic soils. Danso *et al.* (2006) also observed farmers in certain areas of Accra and Tamale combining CM with inorganic fertilizers and stated that the practice was necessary to compensate for a scarcity of organic fertilizers in those areas. Some interviewed farmers (6) did not use CM at all, because of unavailability and lack of experience in using it.

The three subsistence farmers interviewed fertilized their fields with cow manure (priced at US\$0.30 cents per 40 to 50 kg) from nearby kraals. The organic fertilizer was sold by cattle herders also squatting on the property of the University of Ghana. One of the farmers, through an informal arrangement with septic truck drivers, used waste water from the septic tanks of the campus of the University of Ghana to increase the fertility of the soil. Applications were maintained at two tank loads per month to prevent the toxic shocking of crops.

The pesticides, Mektin™ and Karate™, with active ingredients Abamectin and Lambda Cyhalothrin respectively, were popular amongst farmers with irrigated vegetable farms. This is substantiated by a recent study in which high levels of Lambda Cyhalothrin and other pesticides were found on lettuce, cabbage and spring onions from Accra's irrigated vegetable gardens (Amoah *et al.*, 2006). Reports indicate a significant reduction in *Eisenia foetida* cocoon production and hatchability after exposure to a sublethal dose of 0.25 mg Abamectin kg⁻¹ soil (Diao, Jensen & Hansen; Jensen, Diao & Scott-Fordsmand, 2007). Research on the effects of Lambda Cyhalothrin on earthworm cocoon production is scarce. However, some evidence suggests that sublethal doses of the insecticide can significantly reduce the cocoon hatchability of the spiders *Erigone atra* and *Oedothorax apicatus*.

Farmers' dependence on pesticides must not

be understated. Some farmers (11) stressed that there was no point in introducing organic fertilizers without the corresponding organic pesticides to deal with problems concerning the diamondback moth larvae (*Plutella xylostella* Linnaeus) and cabbage leafminer (*Liriomyza brassicae* Riley). A few farmers claimed that the organic pesticide neem seed oil reduced the quality of their produce by making it bitter and was more expensive than conventional pesticides.

Farmers' knowledge of earthworms

All the farmers (29) were aware that earthworm activity had positive impact on soil quality. Nearly half of the farmers (12) surveyed went further and associated the earthworm castings found on fields with good soil fertility. Similar positive attitudes toward earthworms were observed in farmers from Kenya (Murage *et al.*, 2000) and India (Singh & Singh, 2005). Some farmers (14) in our study had been told by fellow farmers and extension workers that earthworms indicated healthy soils. All farmers suggested cool moist locations, especially bath-houses and stream banks, as potential earthworm habitats.

Farmers with irrigated vegetable gardens rarely saw earthworms in their beds, even during tilling. The perception of the farmers was that earthworm populations were reduced by the frequent spraying of insecticides to control the diamondback moth larvae (*P. xylostella* L.) and cabbage leafminer (*L. brassicae* R.). The insecticides applied to control these pests may interfere with cocoon production and hatchability; so it seems reasonable that repeated spraying for many years will eventually eliminate earthworm populations. Subsistence farmers did not use pesticides and found earthworms in their soils whilst tilling during the rainy seasons.

Farmers' criteria for evaluating fertilizer performance

The 29 farmers interviewed mentioned crop performance indicators as criteria for evaluating

fertilizer performance. The frequencies of the indicators were in the following order: greenness of leaves and stalks (23), speed of crop emergence (20), leaf formation (7), and crop yield (4) and stand (3). Studies in Nepal (Desbiez *et al.*, 2003) and Kenya (Murage *et al.*, 2000) also reported that farmers used crop appearance as an indicator of soil fertility.

All the indicators mentioned by the interviewees are related to standard measurements of crop performance and nutrient status in modern agriculture. For example, the greenness of leaves and stalks is related to the chlorophyll content of plant tissues. Deficiencies of nitrogen, magnesium, iron and sulfur may reduce leaf chlorophyll formation and lead to low chlorophyll densities; so greenness is a direct indicator of plant nutrition and nutrient use efficiency from fertilizers (Shaahan, El-Sayed & Abou El-Nour, 1999). The leaf nitrogen content and fertilizer nitrogen requirements of crops can be estimated using a chlorophyll meter, or by making visual observations, as poor UP farmers do in Ghana.

Acceptance of vermicompost as an organic fertilizer

Farmers were curious about the vermicompost product, and were willing to test it once provided with samples. They resisted making statements, predictions, or commitments about adoption before testing. This confirms previous conclusions in other reports that barriers to the use of composted urban organic waste are more technical than cultural (Warburton & Sarfo-Mensah, 1998; Danso *et al.*, 2006).

A few farmers (5) advised that the vermicompost be tested during the dry season, because trials during the wet season would be skewed by the effects of rainfall on crop performance. Others (11) stated that there was little space on irrigated vegetable farms for vermicomposting or any other activities requiring space or land. In addition, irrigating crops, spraying with insecticides, tilling land, applying

fertilizer, and conducting other farm activities did not leave much time for farmers to manage the vermicompost. The three subsistence farmers showed interest in managing their own vermicompost, but lacked the time and resources, especially water and organic wastes, to manage them.

Conclusion

Farmers in Accra were interested in testing vermicompost, but would only pay for the product on condition that it improved crop performance at a reasonable price. Farmers were willing to pay for organic fertilizers, such as chicken manure, because of past successful use in improving crop production. Farmers' fertilizer performance criteria showed a series of standard crop performance indicators also used in modern science. The most popular indicator, greenness of leaves and stalks, suggests the importance of nitrogen fertilizers. In addition, farmers associated earthworms and their castings with healthy and fertile soils.

However, farming practices used for the irrigated vegetable gardens may not allow for the on-site production of vermicomposting; because of the intensive use of pesticides, farmers observe very little earthworm casting on the surface of the soil. Finally, farmers advised testing vermicompost in the dry season to avoid biases introduced by crop responses to rainfall. Farmers from the irrigated vegetable farms admitted time and space constraints would hamper on-site vermicomposting. Subsistence farmers were interested in on-site vermicomposting, but did not have access to wastes and water. The case for small-scale commercial vermicomposting off the farms and the sale of the organic fertilizer to the farms is justified by time constraints and lack of resources of the farmers. Furthermore, the demand for organic fertilizers in Accra is tremendous, estimated at 18,500 ton per annum (Danso *et al.*, 2006) for the 1000 ha of arable land (Obuobie *et al.*, 2006).

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