



## Factors affecting the adoption of compost use by farmers in small tropical Caribbean islands



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### ABSTRACT

Although the use of composts is considered as an option for recycling organic wastes and replacing chemical fertilizers in Caribbean agriculture, little is known about the factors that might encourage farmers to adopt this practice. The aim of this study was to identify the determinants of compost adoption in French West Indies, considering both commercial and on-farm produced composts. A survey including 520 farmers covering a broad range of agro-ecological regions and cropping systems was performed to characterize current uses of compost and the perception of constraints by farmers. Fourteen biophysical and socio-economic variables were included in a logit regression model to explain compost adoption. The adoption rate was 18%, which is relatively low because it was not limited by compost availability. Most adopters declared that they apply composts as an organic amendment and to replace chemical fertilizers to reduce pollution risks. Nearly 60% of adopters apply composts manually and 80% use commercial products. The labour intensity of manual application, the cost of the practice and the lack of information about compost quality were the principal constraints highlighted by no adopter farmers. Compost adoption varied with the cropping system and farmer characteristics. The adoption rate was 40% for banana planters (used as organic fertilizer) and only 3% for sugarcane planters. The experience of farmers and their level of education had a positive effect on adoption, whereas farmer age and a lack of professional organisation affected it negatively. Several levers need to be combined to increase both the adoption rate and the specific rate in sugarcane, which represents one third of the agriculture land. This includes subsidies so that peasant associations can purchase spreaders adapted to different cropping systems, and the development of efficient knowledge dissemination channels.

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## 1. Introduction

Although the appropriate treatment and disposal of organic wastes is a key issue from an environmental and social viewpoint, the implementation of this treatment may represent a serious constraint for industry, local authorities and households (United Nations, 2014). This is particularly true in the small island states of the Caribbean because rapid growth of the population and consumption during the past three decades has been accompanied by the massive production of industrial, municipal and agricultural wastes, which are difficult to manage due to the limited availability of landfill sites (Faverial and Sierra, 2014). In French West Indies, local authorities have proposed composting as a sustainable practice for the recycling of organic wastes as well as to orientate

farmers towards the use of organic amendments (Departmental Council of Guadeloupe, 2011). This is a critical concern in the Caribbean because the overuse of chemical fertilizers for export agriculture, together with climate warming, can cause the severe diffuse pollution of water resources (Castillo et al., 2006) and lead to a decrease in soil organic matter (SOM) (Sierra et al., 2015). The recycling of organic wastes by composting could therefore constitute a win-win strategy by providing a sustainable solution to the dual problem of waste management and poor soil fertility (Lim et al., 2016).

Several studies carried out in both developed and developing countries have shown that traditional supply based policies alone may be unlikely to ensure a suitable level of technological innovation by farmers (Long et al., 2016). For example, most of the failures in composting projects in tropical countries arose from a lack of attention being paid at the planning stage to understanding demand, as well as the technical and economical aspects involved in this practice (Sotamenou and Parrot, 2013; Blazy et al., 2015).

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Blazy et al. (2015) reported that the low rate of adoption of agri-environmental schemes designed in the French West Indies to promote the use of compost was associated with the inadequate subsidies offered by these schemes, which did not compensate for the loss of productivity induced by organic fertilisation. These authors proposed that the adoption rate could be improved through the implementation of mechanization in order to reduce the labour costs linked to compost application. Similarly, Jaza Folefack (2015) suggested that the subsidisation of compost prices should be considered, alongside the development of agricultural mechanization, to increase the adoption of municipal solid waste-based composts by farmers living near Yaoundé (Cameroon). Similar incentives were proposed by Luo et al. (2014) to increase the adoption rate of clean production technologies in China.

Although the use of composts is increasingly being seen as a credible option to chemical fertilizers in Caribbean agriculture (IFAD, 2014), little is known of the factors that might encourage farmers to adopt this practice. Indeed, most studies on the determinants of compost adoption have been carried out in sub-Saharan Africa and South-East Asia where the socio-economic and technical conditions differ markedly from those observed in the Caribbean. For example, most of these studies involved the use of compost produced by the farmer himself, mainly from manure and crop residues. These studies showed that factors such as raw material availability (Kassie et al., 2009), training in composting (e.g. Supaporn et al., 2013) and the number of household members available to make compost (Mustafa-Msukwa et al., 2011) were important prerequisites for its adoption. In the Caribbean, on-farm composting is not a current practice and most of the compost used for export and diversified agriculture is produced by industrial composting facilities from bagasse, sugar scum, manure and green wastes (Sierra and Simphor, 2011). Moreover, the intensification of agriculture following the green revolution introduced crucial social changes in the Caribbean and reduced the importance of cultural customs, which are key factors for the adoption of innovations in some parts of Africa; e.g. household headship and marital status (Mustafa-Msukwa et al., 2011) and cultural taboos against women working in the fields (Kassie et al., 2009). However, other socio-economic and institutional factors such as the age of the farmer, his level of education and access to information, which were successfully applied in many African studies, were also relevant to analysing the adoption of innovations in the Caribbean (Blazy et al., 2011).

In order to help policy makers design new agri-environmental schemes that are more appropriate from the environmental and economic points of view, it is necessary to assess the biophysical and socio-economic determinants of compost adoption. Most of the agricultural land in the Caribbean presents strong spatial heterogeneity characterized by agro-ecological regions of  $10^2$ – $10^3$  km<sup>2</sup> that comprise a mosaic of soils, climates, crops and farming practices (Chopin et al., 2015). In this context, it can be hypothesised that compost adoption rates will depend in part on the characteristics of each region, such as the dominant cropping system (e.g. export agriculture versus diversification for the local market), the level of SOM (e.g. infertile ferralsols versus fertile andosols), farm size (e.g. small-holders versus industrial farmers), and distance to the composting platform. On the contrary, because the production of commercial compost in Guadeloupe is currently higher than the amount of compost used in agriculture land (Sierra and Simphor, 2011), the availability of the product is not a limitation for compost adoption.

The aim of this study was therefore to identify the determinants for compost adoption in Guadeloupe (French West Indies). Agriculture in Guadeloupe involves a mosaic of soils, climates, crops and farming practices, which offers a good representation of the

spatial variability of the agriculture in the Caribbean (Sierra et al., 2015). To this end, 520 farmers, covering a wide range of agro-ecological regions and cropping systems, were surveyed in order to characterize their actual use and perceptions of compost on their farm. We used a logit regression model to assess the impact of 14 biophysical and socio-economic variables on compost adoption. The model was then used to simulate the effects of these variables on compost adoption under different agricultural scenarios, which enabled us to propose the implementation of agri-environmental schemes promoting the use of composts under tropical conditions that would specifically target the constraints experienced by farmers.

## 2. Material and methods

This section presents the research framework of the study including data collection from the survey of 520 farmers, the formulation of the adoption model to assess the impact of the socio-economic and biophysical variables, and the method applied to simulate the behaviour of different farmer types using the adoption model.

### 2.1. Study location

The study was carried out in Guadeloupe, which is located in the Lesser Antilles in the eastern Caribbean Sea (Fig. 1). Guadeloupe has a population of 408,000 and is an archipelago comprising two main islands (Basse-Terre: 848 km<sup>2</sup> and Grande-Terre: 586 km<sup>2</sup>) and several smaller islands. Only the islands of Basse-Terre and Grande-Terre, where there is considerable agricultural activity, were analysed during this study (Fig. 1). Grande-Terre is characterized by a gently undulating landscape where the local relief rarely exceeds 40 m. Soils are vertisols (FAO classification) developed on coral reef limestone. The mean air temperature is 26.5 °C and the mean annual rainfall is 1100 mm yr<sup>-1</sup>, with a dry season from December to May. The agricultural land area is 16,000 ha, which is mainly occupied by sugarcane (48% of land area), grasslands (39%) and diversified agriculture (13%; e.g. melon, tuber and vegetable crops). Western Basse-Terre is dominated by a mountain chain oriented north-west to south-east. The mountain crest stands at 600 m in the north and 1500 m in the south (i.e. La Soufrière volcano). Agriculture is mainly located in the northern, eastern and southern parts of the island, which present elongated hills with convex slopes. Soils are ferralsols in the northern and eastern parts, and nitisols and andosols in the southern part. All soils have developed on volcanic ash deposits. The mean air temperature is 25 °C and the mean annual rainfall varies from 2500 mm yr<sup>-1</sup> in the northern and eastern parts to 3500 mm yr<sup>-1</sup> in the southern part. The agricultural land area is 10,000 ha, which is mainly occupied by sugarcane (44%), banana (21%), grasslands (18%) and diversified agriculture (17%; e.g. pineapple, tuber and vegetable crops, orchards).

Although most of sugar and banana productions from Guadeloupe are exported to European markets, vegetable, tuber, orchards and livestock productions are devoted to the local market. The only sugar factory and composting platform are both located in Grande-Terre. Compost production from that platform is 22,000 Mg per year, whose two thirds is used in agriculture land and one third is used for the maintenance of private gardens and urban green areas (Sita Verde Composting Platform, personal communication). This points out that in this study compost adoption by farmers was not limited by the availability of the product.

### 2.2. Survey design

In order to analyse compost adoption by farmers, data were

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