
Ex ante assessment of the cost-effectiveness of Agri-Environmental Schemes promoting compost use to sequester carbon in soils in Guadeloupe

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Résumé

Maintaining soil organic matter is critical to tackling climate change because soil organic matter is rich in carbon. Soil carbon is also the keystone element controlling soil health, which enables soils to be resilient as droughts and intense rainfall events increasingly occur (Lynch, 2014, 2019). Yet, soil carbon stocks have been decreasing for more than a century, due notably to an increase in agricultural land, the intensification of deforestation, the shortening of fallow periods, the increasing use of agricultural heavy machinery and the decrease in organic fertilizers. Faced with this problem, what instruments should governments use to encourage farmers to improve soil carbon on their farms?

For several years now, the European Union's Common Agricultural Policy (CAP) has implemented Agri-Environmental Measures (AEM), to encourage ecologically friendly practices such as adding compost to the soil.¹ However, farmers' participation in these schemes is often low and their effectiveness has not always been demonstrated (Behaghel, Macours, and Subervie, 2019; Kuhfuss and Subervie, 2018; Arata and Sckokai, 2016; Chabé-Ferret and Subervie, 2013; Pufahl and Weiss, 2009).

The determinants of farmers' adoption of innovative, sustainable agricultural systems have been a central question of research in agricultural economics for a long time (Sunding and Zilberman, 2001). The challenge is to identify the obstacles to the adoption of the most innovative agri-environmental techniques on the one hand, and the public policy instruments that can remove these obstacles on the other (Espinosa-Goded, Barreiro-Hurlé, and Ruto, 2010). In the context of a limited EU budget, high priority should be placed on the cost-effectiveness of public schemes. For this reason, ex-ante evaluation of the cost-effectiveness of environmental programs – i.e. determining the maximum environmental benefit for a fixed cost or the minimum cost of achieving a specific environmental outcome – has become a central concern of public authorities in the last ten years (Thoyer and Préget, 2019; Colen et al., 2016; Smismans, 2015). However, such evaluations have rarely been undertaken so far.

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In this article, we perform an ex ante evaluation of the cost-effectiveness of a series of innovative AEM designed to promote the use of organic soil enrichments containing compost among farmers in Guadeloupe. The proposed analysis includes (i) predicting the participation rate of farmers in each AEM, (ii) simulating the environmental impacts of the adoption of each AEM in areas with possibly heterogeneous land uses and pedoclimatic conditions, and (iii) computing and extrapolating environmental gains and economic costs in order to rank the AEM considered according to their cost-effectiveness. To do so, we make use of an original methodological procedure, combining a choice experiment involving 305 volunteer farmers with biophysical simulations of the effects of the adoption of the proposed measures on soil carbon sequestration in Guadeloupe.

We ran a choice experiment in the western islands of French Polynesia where the soil organic carbon content is extremely low. The farmers who participated were asked to choose one of several AEM that offer financial support in exchange for using compost in their farming activities. In addition to financial support, we studied three potential levers for improving farmers' participation rates in the AEM encouraging compost use: free technical assistance, a collective financial bonus, and the possibility of combining chemical fertilizers with composts. We found that offering free technical assistance increases the participation rate by 30 percentage points and offering a collective bonus increases it by 14 percentage points. In contrast, including a requirement on the reduction of chemical fertilization would decrease the probability of participation by only 2 percentage points.

We then estimated the amount of carbon that would be sequestered in the soil using compost as prescribed under the AEMs proposed. We found that the most effective measure sequesters up to 25,000 teqCO_2 per ha and per year and that the most cost-effective measure reaches this target at a cost of about 500 euros per teqCO_2 . Finally, we find that the 4 per 1000 target launched by France at the 2015 United Nations Climate Change Conference (Minasny et al., 2017) could be easily reached through most cost-effective measures even if only half of the farms (specifically the largest ones) were enrolled in the program.

A number of studies have run ex-post evaluations of the impact of environmental programs in developed countries (Lynch, Gray, and Geoghegan, 2007; Lynch and Liu, 2007; Pufahl and Weiss, 2009; Chabé-Ferret and Subervie, 2013; Arata and Sckokai, 2016; Kuhfuss and Subervie, 2018) and developing countries (Robalino and Pfaff, 2013; Arriagada et al., 2012; Alix-Garcia, Shapiro, and Sims, 2012; Alix-Garcia, Sims, and Yanez-Pagans, 2015; Costedoat et al., 2015; Sims et al., 2014; Jayachandran et al., 2017), to cite only some of them. Apart from a few exceptions (Chabé-Ferret and Subervie, 2013; Jayachandran et al., 2017), no study has attempted to translate the additional effects on land use into environmental gains in order to compare them with the costs of the program. In the literature that focuses on ex-ante evaluation of environmental programs, a growing number of studies rely on choice experiments to estimate farmers' willingness to provide ecosystem services (see for example Kaczan, Swallow, and Adamowicz (2013) and references therein, Villanueva et al. (2017), or Latacz-Lohmann and Breustedt (2019) for more recent references). However, very few attempt to then use these estimated participation rates in broader frameworks that would allow for an estimation of the cost-effectiveness of the program under study, something we aim to do in this paper.

Mots-Clés: soil carbon, compost, climate change, choice experiment, Guadeloupe.