

## **Possible applications and critical aspects of carbon nanomaterials use in agriculture**

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In the last decades the research on nanomaterials (NMs) increased dramatically. Nevertheless, only about 1% of this was focused on the use of carbon based materials (CBMs), such as carbon nanotubes (CNTs), fullerenes, fullerols, and, recently, graphene based materials for agricultural applications. Promising achievements have been obtained using CNTs and fullerols as nanofertilizers, since their addition in artificial media improved flowers and fruits production of several crop species. CNTs and fullerenes have also been used successfully to decrease bioavailability of soil contaminants suggesting their potential applications in soil remediation. Less explored applications include the use of CBMs, such as graphene oxide and reduced graphene oxide, to improve the effects of pesticides. Despite the broad range of potential applications, the use of CBMs in agriculture has to be carefully considered for a number of reasons. The above-mentioned effects were not consistently confirmed since also negative species- and concentration-specific effects have been highlighted. The information on CBMs toxicity on human health and the environment is frequently contradictory and there is hardly any information on their environmental fate. Furthermore, the international regulation is not fully consistent because even if it fosters investments for the development of CBMs-based technologies it did not develop yet a homogeneous regulatory framework dedicated to CBMs use and control. Hence, before introducing CBMs into the environment in the quantities and with the frequency requested by the most innovative agricultural practices, CBMs should be carefully tested from the ecotoxicological point of view and, if necessary, modified to obtain “safe-by-design” products.