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Reduction of the efficacy of biochar as soil amendment by soil erosion

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Biochar is primarily used as soil amendment to improve soil quality and to sequester more carbon (C) to increase both medium- and long-term soil C stocks. These positive effects are obviously diminished if biochar is eroded and transported out of the field. Due to its low bulk density, the preferential mobilization and redistribution of biochar in the landscape seems probable. Therefore, the question has been raised in recent years of how vulnerable biochar actually is to soil erosion. This is especially relevant on soils which are regularly cultivated and are vulnerable to soil erosion themselves. However, so far few studies about the erodibility of biochar exist and the answer to this question is still unknown. It is therefore important to further our knowledge about mobilization and transport behaviour of biochar. Moreover, such knowledge could have profound economic implications for farmers committed to its use, as a high net annual loss of biochar by erosion could exceed any net annual economic gain. The overall objective of this study was, therefore, to investigate the erodibility of biochar, when erosion events occur directly or soon after its application. The estimation of the financial value of the eroded biochar and its cost-effectiveness were scaled up from plot to field scale. In this investigation, the biochar was applied to the soil surface of three plots on a recently cultivated sandy field near Viborg in northern Jutland, Denmark at concentrations equivalent to 1.5-2.0 kg m-2. After application, the biochar was manually incorporated into the till-zone (20cm). With the Portable Wind and Rainfall Simulator erosion events of a duration of 30 minutes and with a rainfall intensity of approx. 90 mm h-1 were conducted on both biochar and reference plots. The erodibility of biochar by wind erosion was due to very rainy wet soil surface conditions, tested with dried soil in the laboratory, in order to be able to at least reflect the worst case scenario. The results of the study show that for both experiments (wind and water erosion), the sediment from plots with biochar application contains more carbon than sediment eroded from reference plots. This indicates that a considerable amount of biochar can be eroded from the fields within the first rainfall or storm events after biochar application to the soil. The economic loss of the biochar particles from a single event account for 3-32 €ha, depending on the carbon content of the biochar and the general erodibility of the soil itself. This seems to be negligible, but considering that (1) the amount of applied biochar was very low, (2) strong rainfall events occur quite often in Denmark, and (3) that the frequency of heavy rainfall will most probably increase under future climatic conditions, the economic losses to landowners could be severe.