Experimental analysis of farmers' willingness to participate in carbon sequestration programmes

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Increasing atmospheric concentrations of Greenhouse Gases (GHGs) contribute to global warming and thus climate change (Hegerl et al. 2019; Wang et al. 2019). In 2018, 81% of the European Unions (EUs) total GHG emissions consisted of carbon dioxide. Since agricultural soils offer huge carbon sequestration capacity, agriculture can contribute to climate protection (Janzen et al. 2022). The carbon sequestration potential of agricultural soils is ranging worldwide from 5% to 15% and is three times that of atmospheric carbon pool (Freibauer et al. 2004; Lal 2004; Luo et al. 2010). Carbon dioxide from the atmosphere can be transferred into the soil through plants, plant residues and other organic solids which are counted as soil organic matter, also called humus (Chenu et al. 2019). To increase the humus content of the fields which indicates an increase in carbon sequestration, farmers can apply different carbon farming practices, for instance cultivation of catch crops, direct sowing, application of compost or agroforestry systems.

Assertive policies promoting this pathway are warranted since the objective to limit the global temperature increase to 2°C was adopted in the framework of the Paris Agreement in 2015 (Zomer et al. 2017; Minasny et al. 2017; UNFCC 2015). A policy measure labelled as 'certificate' instead of 'subsidy' leads to equal efforts in carbon sequestration but increases heterogeneity of carbon sequestration promotion (Hermann et al. 2017), thus certificates can be an effective policy measure. Non-governmental organisations developed humus certificates in the framework of humus programmes. In humus programmes, companies or private individuals can purchase humus certificates to improve their carbon footprint. The sale of the humus certificates finances humus premiums that are paid to farmers who apply carbon farming practices to increase the humus content and thus to capture carbon from the atmosphere in the soils (Ökoregion Kaindorf 2022; Positerra 2022).

In existing humus programmes, the humus content of the corresponding fields is determined at the beginning of humus programmes in order to have a reference value for the future humus increase. Three to seven years later, the humus content is measured again at a success investigation and is compared to the reference value to detect whether the humus content has increased. In case of success, a basic premium is payed to the farmer proportionally or in full, depending on the programme. Three to five years later, a control investigation is made to check whether the humus content was maintained. If so, farmers get the remaining part of the basic premium if they have not received the entire premium at the success investigation. If farmers already received the full basic premium and the humus content has decreased until control investigation, they have to pay back the basic premium proportionally (Ökoregion Kaindorf 2022; Positerra 2022).

Humus programmes are relatively new and unexplored. Thus, there is no literature about adoption, preferences, or optimal structure of carbon sequestration programmes from farmers' perspective as a basis for policy makers and non-governmental organisations. The objective of this study is to elicit farmers' willingness to participate in a humus programme. More precisely, we analyse whether and to what extend specific programme requirements influence farmers' willingness to participate. The overall aim is to derive implications for well-structured and attractive humus programmes in order to increase the number of farmers who are willing to participate. This in turn may lead to an increase in humus content and carbon sequestration, which is a great contribution to anthropogenic carbon dioxide reduction and climate protection.

In order to reach the study objectives, a discrete choice experiment (DCE) was conducted. By using a mixed logit model (MLM), farmers' willingness to participate in a humus programme and farmers' preferences were analysed. For this, a data set of 150 German farmers was collected via an online survey in 2022. We focused on German farmers because Germany is one of the greatest GHG emitter in Europe, but simultaneously Germany has more ambitious climate protection goals than other countries in the EU. Therefore, Germany has a leading role in international climate protection (Eurostat 2018; Parker and Karlsson 2010; KAS 2016). To the best of our knowledge, this is the first

study which investigates farmers' willingness to participate in carbon sequestration programmes and the effectiveness of specific programme requirements.

The results of the MLM show that farmers in our sample generally do not have a statistically significant preference for participating in a humus programme compared to no humus programme. However, farmers who are willing to participate in a humus programme prefer a field-specific reference value instead of a regional average reference value, by which the humus increase and thus the pay-out is measured. Furthermore, a higher basic premium and a longer programme duration results in an increasing willingness of farmers to participate. In contrast, a minimum increase of the humus content, which is required for the pay-out of the basic premium at the success investigation, should either be very low or it should be removed completely since a higher minimum increase leads to a decreasing willingness to participate. Moreover, farmers decline the option of an additional premium/repayment due to a humus increase/reduction at the control investigation if there is an alternative programme with no additional premium/repayment. This suggests that a repayment system discourages farmers from participation and its implementation is not recommendable.

The study findings should be considered from policy makers dealing with carbon farming, non-governmental organisations who offer humus programmes and researchers on agricultural climate management since we provide deeper insights into farmers' preferences concerning a carbon sequestration programme. Policy makers and non-governmental organisations can be given advices relating to the development and optimisation of humus programmes, e.g. not to implement a repayment system. Researchers can use our results as first indications concerning adoption and potential of carbon sequestration programmes.

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